THE

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THE

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THE BOARD OF TRADE AND THE PROPOSED NEW REGULATIONS.

ELECTRIC lighting undertakers, and, indeed, the profession generally, may congratulate themselves upon the results of the conference held by Sir Courtenay Boyle at the Westminster Town Hall on Tuesday and Wednesday in last week. There was from the start an evident desire on the part of the Chairman and the other officials of the Board of Trade to meet the views of the meeting as far as was consistent with the proper protection of the public safety, and several important concessions were made. The new regulations, as amended, are far more favourable to the interests of the profession than those in existence at the present time. On some of the more important points Sir Courtenay Boyle showed a decided disinclination to make any alteration, but the persuasive eloquence and clear and logical argument of the various speakers resulted generally in a compromise favourable to the profession.

The first—and by no means the least important—subject discussed was that of "pressure," upon which the debate lasted considerably over an hour. The "low pressure" section of the industry was, as might be expected, here very much in evidence. They ardently desired that the definition of "low pressure" should be altered so as to allow of much higher figures than those provided in the draft new regulations or the existing regulations, viz., 300 volts if continuous, or 150 volts if alternating. The prevailing opinion seemed to be that 600 volts should be admitted as "low pressure." On Tuesday Sir Courtenay Boyle decided to advise the Board of Trade to raise the limit in the case of alternating current to 220 or 250 volts, and expressed his own opinion that, in the case of continuous currents, it might be raised to slightly above 300 volts. During the first day's sitting the question of pressure was continually cropping up, with the result that on Wednesday morning the Chairman announced that the subject was a difficult one, and that he thought it advisable to recommend the Board of Trade to appoint a committee of experts, who should carefully consider the whole question from a scientific standpoint and advise the Board of Trade.

Whether or not the result is satisfactory will depend upon the experts chosen, and the manner in which the inquiry (if such it is to be) is conducted. We all know that the Electric Lighting Bill, which resulted in the Act of 1882, was drawn up under the advice of "experts," and the result cannot be said to be altogether satisfactory. The inquiry should be a public one, and not simply a private sitting of experts; it should be of the most exhaustive character, and the question of alternating *versus* continuous currents should be carefully considered. There appears to be no valid reason why an invidious distinction should be made between continuous and alternating current supply. From the Board

of Trade point of view, viz., public safety, no distinction is necessary, for no conclusive evidence has ever been adduced that the alternating current is more dangerous to life than the continuous current, the pressures (as defined by the regulations) and other things being equal. The definition referred to is as follows:—

"Pressure on any alternating current system being taken to be the equivalent of pressure on a continuous current system when it produces an equal heating effect if applied to the ends of a thin stretched wire or carbon filament."

It is curious to note that in the definitions of "high pressure" the distinction does not appear, and the words "whether continuous or alternating," are substituted, presumably upon the assumption that at 3,000 volts pressure, "whether continuous or alternating," a shock is certainly fatal. It is impossible to decide generally at what pressure electricity becomes dangerous to life, but both from the point of view of public safety, and in the best interests of the electric lighting business, the factor of safety at the consumers' terminals must be a high one. Should a serious accident occur (though not necessarily a fatal one) in a private house or elsewhere, where the public have free access, the result would, undoubtedly, be most detrimental to the industry. It is worthy of notice that the advocates of the "low tension" system whose favourite argument was "safety," and who were content with 100 or 110 volts, are now doing all they can to prove that 600 volts pressure is innoxious, so as to avoid stultifying themselves! Far better to incur the cost of a few extra tons of copper than to run the risk of doing irreparable injury to an undertaking which is not yet in a position to ignore public sentiment.

Clause 4, which provides that "no high pressure electric line shall be used for the transmission of more than 200,000 watts," called forth a good deal of discussion, after which Sir Courtenay Boyle confessed that he considered the figure given too low, and would advise the Board of Trade to increase it; but he was not prepared at that time to say what increase he should recommend. He would not, however, advise 500,000 watts, as had been suggested. The reason—as Major Cardew pointed out—that they were anxious to put a limit upon the amount of energy transmitted along any line, was to limit the explosive effect in the conduits, due to the sudden expansion of the air in case of a short circuit.

The objectionable feature of Clause 7, which rendered the use of automatic cut-offs in the mains compulsory, is to be eliminated, and wisely so, as the use of fuses or cut-offs are in many cases only a source of trouble, and frequently interfere with the continuity of the supply. The works' engineer should be capable of looking after and providing for the protection of his plant and mains. The concession made by the Board of Trade, in the case of Clause 9, was greeted with applause. The clause originally provided that "no electric line shall be brought into use in which this test (previously described) indicates an insulation resistance less than at the rate of 100,000 ohms per mile for every volt of pressure of the supply, &c." This, the users and advocates of bare copper mains stated, was impossible.

The clause is an old one; but in the existing regulations it deals with high tension only, while in the proposed regulations the words "high tension" are omitted, hence the consternation and subsequent relief of the low tension people.

Clause 13, which provides that "no electric line, machine, device, or apparatus intended to form part of, or be connected with, a high pressure circuit, shall be brought into use unless the insulation thereof has withstood the continuous application during one hour of twice the pressure to which it is intended to be subjected in use," received a good deal of opposition, and Sir Courtenay Boyle eventually consented to advise that, in the case of machines and apparatus, the pressure should be reduced to 50 per cent. Why even this test should be necessary does not appear, as the breaking down of a machine usually affects the undertakers alone, and in no way jeopardises the public safety, while the pressure required is very far in excess of that to which it could ever be subjected under working conditions.

Clause 27 was intended to take the place of Clause 14 in the existing regulations; but while the latter only requires the undertakers to efficiently protect their conduits from *accumulations* of gas, the former would, if insisted upon, require them to make all their conduits gas-tight, or, in the wording of the clause, "prevent any *influx* of gas from the adjacent soil."

It was anticipated that Sir Courtenay Boyle would object to alter the clause, and, as a natural consequence, the speakers emphasised the great injustice that would be done to electric lighting undertakers if the clause remained in its proposed form, while it would largely strengthen the defence of the gas companies in the event of explosions occurring in the conduits. It was suggested that if it was true—as was frequently stated by gas companies—that it is not possible to prevent leakage from gas mains, it was unreasonable to expect the undertakers to make their conduits impervious to gas, and obviously unfair to throw the responsibility upon them. When it was found that Sir Courtenay Boyle was prepared to meet the views of the meeting, the greatest satisfaction was expressed in the applause which followed. In its amended form, the clause will require the undertakers to take reasonable means to prevent accumulations of gas, and to frequently inspect their street boxes, giving immediate notice to the gas authority should the presence of gas be discovered. The exact wording of the clause, however, has not yet been decided upon.

In connection with this gas question, there is another matter requiring the serious and urgent attention of the Board of Trade. In the early part of the year the Islington Vestry memorialised the Board of Trade, urging that steps should be taken, by legislation or otherwise, to obtain greater control over gas companies as regards any escape of gas from their mains. They also asked the other Metropolitan Vestries and electric lighting authorities to make similar representations, and, in a number of cases, this was done. Now, the Board of Trade, as guardians of the public safety, cannot consistently ignore such representations, and there appears to be no valid reason why they should not promote a Bill in Parliament with this end in view. That it would meet with strong opposition from those interested may be expected, but the argument that it is necessary in the interests of public safety, and that electric lighting undertakers are subject to the control of the Board of Trade, is unanswerable. We have been for a time comparatively free from explosions, but it only requires the necessary combination of conditions to produce a repetition of the trouble which created such a scare last winter. The recent accident in the Strand, which was attended with such disastrous results, should be sufficient

to remind the Board of Trade that no amount of care on the part of electric lighting undertakers can prevent explosions of gas. Leakages from gas mains into private and business premises, sewers and other places, are by no means uncommon, and there is at least one case on record in London in which the gas managed to get into several water services and contaminated the water. Electric lighting undertakers should not, and must not, allow this matter to rest until gas companies have been placed under the control of the Board of Trade, and subjected to proper restrictions and supervision.

Clause 33 provided that "Every high pressure electric line transmitting more than 50,000 watts . . . . shall, except within the generating station, be entirely enclosed in strong metal casing, efficiently connected with earth," &c.

Clause 34 referred to high pressure lines transmitting not more than 50,000 watts, and provided that they should be laid at a depth of not less than 2 feet from the surface of the ground. Both clauses were struck out, and Clause 8 in the existing regulations substituted.

Clause 35, which provided that all street boxes should be so constructed as to prevent influx of gas, has now been amended, and refers to street boxes used as transformer chambers only. Ordinary street boxes are now included with conduits in Clause 27, previously mentioned. As the subject of Clause 37 was already provided for in Clause 29, it was struck out.

Clause 38: "All converting stations or points in a system of distribution to which a high pressure supply is given from generating stations, and from which a low pressure supply is given to consumers, shall be established in suitable places, which are in the sole occupation and charge of the undertakers"—would, of course, include consumers' houses in which a transformer was fixed, and as considerable objection was raised, it was struck out, and Clause 16 in the existing regulations substituted.

Clause 43 provided that "Where transformers are installed within buildings on consumers' premises, they shall be contained in a fireproof chamber," &c. This was struck out, and clause 18 in the existing regulations substituted, which permits of the transformer being enclosed in strong metal casing efficiently connected to earth.

The last clauses which called forth any considerable discussion were Nos. 44 and 45. These deal with faults which may occur on consumers' premises, and provide that if the insulation is found not to exceed 5,000 ohms, the undertakers shall forthwith disconnect such premises from their mains. It was pointed out to Sir Courtenay Boyle that undertakers had no power to disconnect until the insulation fell to 5,000 ohms, which was far too low, and a permissive clause was suggested, enabling disconnection to be made at a much higher point of insulation, if it were found desirable.

It was ultimately decided that undertakers shall not permanently commence supplying current to any premises if the insulation was found to be less than—*—megohms, divided by the number of lamps, and that they shall disconnect any premises in which the insulation shall have fallen below that provided. The power given to undertakers under this clause was very badly wanted, and the old clause was an obvious absurdity and utterly unworkable.

During the two days' conference Sir Courtenay Boyle was continually being asked whether or not the regulations would be retrospective, and it was generally understood that such would be the case, except where it was specially provided to the contrary. As we have said, the result of the conference has, on the whole, been very satisfactory, and shows that the Board of Trade and electrical engineers are on very good terms.

* The actual figure is to be decided by the Board of Trade, and will probably be something between 10 and 75.

New Light on the Grove Battery.

Chemists used to be very fond of ascribing reactions, which they experienced some difficulty in explaining, to "catalytic action"—a conveniently vague term which is almost Gladstonian. We have not quite done with it yet, although the time is probably not far distant when this rather weak term will be supplanted by something more understandable. For the present, however, it is still thought desirable to retain it. In a recent issue of the *Electrotechnik und Elektrochemie*, 1895, II., p. 174, Ihle calls attention to a form of catalytic action which, apparently, can be recognised in the Grove cell. He finds that if the concentrated nitric acid in a cell of this type be gradually diluted with water, the E.M.F. of the cell remains approximately constant and equal to 1·8 volt until 38 per cent. of nitric acid is present. A little below this concentration the cell gives an E.M.F. roughly corresponding to that of a Smee cell (0·7 volt), although at first it only exhibits this lower E.M.F. for a short time. When the amount of nitric acid present is reduced to 27—28 per cent., the E.M.F. of the cell remains permanently at the lower value. Ihle is of opinion that this remarkable phenomenon is due to the action of nitrous acid, which is either contained in the nitric acid to start with or else is formed in it when the circuit is closed. Support for this view may be found from the following experiments:—If a Grove cell be used which contains less than 28 per cent. of nitric acid and, therefore, exhibits permanently an E.M.F. equivalent to that of a Smee cell, and a small quantity of potassium nitrite be added, the E.M.F. instantly rises to that of the normal Grove cell. On removing the nitrous acid by adding potassium permanganate or urea, the E.M.F. again sinks to that of the Smee cell. And even with more concentrated nitric acid the depolarising power can be annulled if the nitrous acid be removed by similar chemical means, the E.M.F. then falling to that of a Smee cell. With acid containing over 50 per cent. of nitric acid this can only be done for a short time, but with acid containing 50 to 38 per cent. the effect is permanent. From these observations Ihle argues that depolarisation in the Grove cell takes place, seemingly by a catalytic action of nitrous acid. It may be remembered that V. H. Velley has observed an analogous phenomena, so that it is to be hoped that these new results may stimulate further research.

The Future of Sewage Purification.

Of all the schemes for purifying sewage which have been placed before the municipalities of this country there is probably not one against which grave objection may not be urged, either on the score of efficiency or economy. So far the best results appear to have been obtained by combined chemical precipitation with mechanical filtration, the effluent being passed through land or filter beds. This combination, however, is exceedingly costly and cannot wisely be adopted by other than wealthy communities; moreover, no such combination can be called a complete success, for either too little chemicals is used with a view of keeping down the expense, or a large amount is employed with the result that the effluent is so highly charged with lime, alum, copperas, perchloride of iron, &c., that any stream into which it is turned becomes seriously polluted. In the *Engineering Magazine* (U.S.A.) W. L. Hedenberg publishes a thoughtful paper on the future of sewage purification. After reviewing the methods which have been exploited so far, he concludes that it is time that engineers were branching out into some new lines of enquiry with a view of discovering a method by which liquid waste may be as thoroughly purified as by filtering through sand or earth. He thinks that electrical energy will undoubtedly be the great purifying agent of the future. Two well known methods of manufacturing a disinfecting liquid by means of electricity have appeared during the last few years, but the writer is of opinion that neither the Woolf nor the Hermite system completely satisfies the conditions; nor does he think they embody any finality to research in this direction; other systems are described and criticised, amongst them that of Webster. We are at one with the writer in believing that the purification of sewage by electricity is in its infancy, and we hope that electricity is destined to play an important *rôle* in the sanitation of the future. At any rate, it is clear that the results so far obtained by the different electrical systems which have been tried, justify careful study and research in this direction by all progressive sanitarians.

TESTS OF INCANDESCENT LAMPS.*

In our issue of October 4th, we gave tests of incandescent lamps made by Mr. D. Paisley, 152, Rue de Cologne, Brussels. The lamps were manufactured by the foremost firms in England and the Continent, 17 in number. No intimation was made by Mr. Paisley to the manufacturers mentioned that he intended to make a test. What he wanted to test was the average value of the lamps to any ordinary purchaser, and for this purpose he obtained the lamps in the same way as an ordinary purchaser would obtain the lamps, namely, over the counter. It was not a test of carefully prepared lamps made specially by the manufacturer to show what he could make. It was a test of lamps for the purchaser, and necessarily obtained in the only way the purchaser could obtain them. Here are the exact conditions under which they were obtained in Mr. Paisley's own words :—

"The figures show the results of a time trial of lamps run at a voltage marked on the lamp, and sold to the writer as being of such voltage, but not being in any way of special quality, the lamp having been sold 'over the counter' without the purpose of the purchase having been mentioned. The net prices are also given for the small quantity, purchased by him, namely, 12 of each sort, six of which were used in the time trial, and numbered respectively 1, 2, 3, 4, 5, and 6, in the tables given."

It appears to us as the old question of the test of an engine and boiler on the trial trip and under ordinary working conditions. The test of the engine and boiler is on the trial trip the maker's test, and their test in going across the Atlantic is the owner's test. So it is with lamps. A show test of incandescent lamps selected and sent in by the manufacturers would be a maker's test. The test made by Mr. Paisley of lamps bought in the ordinary way, at the prices which he has marked down, is a purchaser's test. It was meant for this. We did not present the tables as being anything else, and they are very valuable to the public as such.

In the explanatory article which accompanied the tables, we pointed out that the price of the lamp was not the only factor to be considered. The amount of current consumed, and the fall in the lighting power of the lamp, were of the highest importance in view of the low primary cost of the lamp. There was the voltage and the ampères consumed, and these had their commercial value. In fact, the energy or watts consumed by the lamp during its life had to be included in any estimate of value of the lamp. Before we can properly estimate the value of an incandescent lamp, we must know four things :—

1. The primary cost.
2. The cost to him of a watt.
3. The candle-power of the lamp for the time under consideration.
4. The length of life of the lamp in hours.

When these things have been determined, and the tables we gave supplied them, then the purchaser is in a position to know exactly what lamp under his conditions will suit him best.

The question, of course, to the consumer is : What is the total price of a candle-power per hour for any lamp to me ? Into this comes the primary cost, the candle-power, the life, and the cost per watt to the purchaser of the lamp. Writing this in mathematical terms we have :—

$$\text{Price per C.P. per hour} = \frac{\text{Primary cost of lamp} \times \text{cost of watt} \times \text{No. of watts per C.P.}}{\text{Life of lamp in hours.}}$$

The table referred to gives the primary cost of each lamp, the number of watts used per candle-power at different stages of the life of the lamp, and the life of the lamp in hours, and therefore all the elements supplied for estimating the value of any lamp in the way shown above. What, of course, is required is the cost of a candle-power for each lamp per hour. We do not propose to set up a comparison between the lamps made by manufacturers, but to show how the value to the purchaser and consumer may be determined. For this purpose we take three lamps made by three manufacturers who have been referred to in this and contemporary journals. The three names are the "Robertson," the "Sunbeam," and the "Edison and Swan," and as it is merely an illustration, we do not select any particular lamp, but those marked 1 in the first set of tests.

Taking, then, the Edison and Swan first, and No. 1 lamp of the old manufacture, we find that at the beginning of the test the watts required per candle are 3·83 and 4·7 at the end. The average watts per candle-power is thus 4·26. Assume that the cost of a Board of Trade unit is 8d. The life of the lamp is given as 600 hours. Hence, applying the rule, we get

$$\text{Cost of C.P. per hour (Edison-Swan)} = \frac{\text{Primary cost of lamp} \times \text{cost of watt} \times \text{No. of watts per C.P.}}{\text{Life of lamp in hours.}}$$

$$= \frac{21}{600} \times \frac{8}{1{,}000} \times 4{\cdot}26$$

$$= {\cdot}00119 \text{ pence.}$$

Secondly, taking the Sunbeam No. 1 lamp, we find that at the beginning of the test the watts required per candle are 3·5, and at the end 5·7 watts. The average watts will then be 4·6 Taking the same cost, per Board of Trade unit, namely 8d., the life of the lamp is given as 600 hours, and the price 15½ pence. Applying this rule we have

$$\text{Cost per C.P. (Sunbeam)} = \frac{15{\cdot}5}{550} \times \frac{8}{1{,}000} \times 4{\cdot}6$$

$$= {\cdot}00095 \text{ pence.}$$

Lastly, taking the Robertson No. 1 lamp, we find that at the beginning of the test the watts required per candle are 3·94, and at the end 4 watts ; the average watts required per candle-power will then be 3·97. Taking the same cost per candle power, namely 8d., the life of the lamp is given as 600 hours, and the price as 16 pence. Applying the rule, we have

$$\text{Cost per C.P. (Robertson)} = \frac{16}{199} \times \frac{8}{1{,}000} \times 3{\cdot}97$$

$$= {\cdot}000807 \text{ pence.}$$

Reference has been made in a letter from Mr. F. Walker, referring to the Gabriel & Angenault lamp. The average number of watts required for this is 3·28 per candle-power per hour, and the price is 12 pence ; so,

$$\text{Cost per C.P. per hour} = \frac{12}{600} \times \frac{8}{1{,}000} \times 3{\cdot}28.$$

$$= {\cdot}000528 \text{ pence.}$$

As we said above, we do not put forward these values for the purpose of comparison, but only as an illustration of the manner in which the value of a lamp must be obtained before it can be of any practical value to the purchaser. If an average for all the lamps in the above were obtained and tabulated, the values so obtained would be of considerable practical value to the purchaser. This we reserve for another time.

A useful table is given by Mr. C. J. Robertson, in a contemporary, for the cost and maintenance of six lamps, made by three manufacturers besides his own. The cost he takes at 6d. per Board of Trade unit, and also at 8d. per Board of Trade unit. The comparison in the tables is in favour of his own lamp, as it is in the above lamps, selected at random, to show the method of calculation.

At another time we trust to have time to give a table showing the cost of each of the lamps in the table per candle-power per hour.

* *Industries and Iron.*

THE NORMAN TESTING SWITCH.

In cable factories and central stations the saving of time in taking tests of cables and wires is a matter of importance, further, in central stations it is advisable that the apparatus necessary for taking these tests should be as compact, as simple in manipulation, and as unlikely to get out of order, as possible ; in fact, for central station work, it would be a considerable advantage to have the apparatus so arranged that no special knowledge of the work of electrical testing is required, in order that an ordinary dynamo attendant might take all tests required with rapidity and accuracy. An instrument which to a considerable extent meets these

requirements has been designed by Mr. H. D. Norman, of the Telegraph Manufacturing Company, of Helsby, and has been adopted by that company in their testing rooms. It performs by one simple movement of one lever only, all the operations which usually require a discharge key, a set of shunts, short-circuit key, battery key, and cable key, &c. Messrs. Nalder Bros. & Co., of Clerkenwell, are (under license) the sole makers of these instruments.

The following is a description of the switch, showing the actual form adopted by the Telegraph Manufacturing Company, in the photograph, fig. 1, and one or two other

Fig. 1.

forms. Fig. 2 shows the connections of a switch on a constant damping shunt principle; fig. 3 one on an ordinary shunting principle, this latter, however, will not be described as its working can be easily followed from the diagram. Referring to fig. 2, the action of this switch is as follows:—In its "free" position, *i.e.*, before starting to test, the switch lever, C, which is simply a metallic connection between the two sides of this switch, is at position and

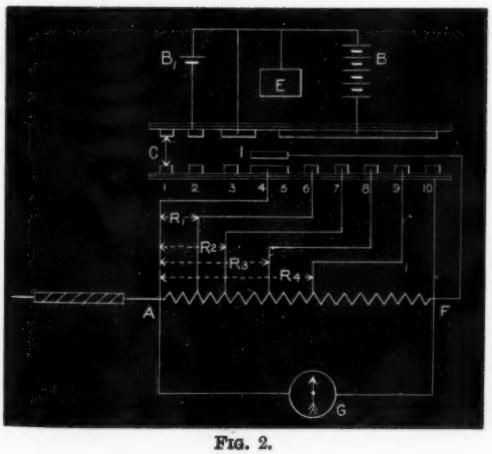


Fig. 2.

contacts, 1, in which position the cells are totally disconnected from the galvo, G, and cable. By moving the lever to contact, 2, the cable or wire under test is charged from the cells or cell, B_1, the next movement to a position midway between contacts 2 and 3, puts the cable or condenser to insulate for observations of loss of charge, and this final movement (for capacity) to 3 discharges the cable or condenser.

The contacts shown on the galvo side of the switch have holes drilled in their outer faces to receive plugs (shown in the photo), the object of these plugs with a flexible connection between being to connect any shunt to position 3 for capacity or earth readings. Supposing, therefore, a $\frac{1}{10}$th shunt was required to lessen the discharge deflection of the particular cable or condenser under test, contact 3 would be connected to contact 9, and the path of the current would then be from cable connected to A through A—9 and A, G, F—9 in parallel, thence by cord and plugs to 3 and thence through lever to earth. For insulation resistance tests the lever is now moved to 5, and by this movement the cable is charged from the cells, B, with the galvo cut out and short-circuited, the short-circuiting being effected by an insulated fork contact on the lever connecting the strap I to 5; the switch lever is then moved in a left to right direction, the current flowing in A, G, F, being $\frac{1}{10000}$th, $\frac{1}{1000}$th, $\frac{1}{100}$th, or $\frac{1}{10}$th the total current flowing into cable at A, the "no shunt" position being reached at 10; this is, of course, provided that the cable is sufficiently well insulated or is short enough to make shunting unnecessary, the switch travel being stopped when the maximum observable deflection is shown on the galvanometer scale and the necessary electrification readings taken. These having been observed and noted, if no earth readings are required, the switch lever, C, is returned to position 4, which discharges the cable, the galvanometer being cut-out

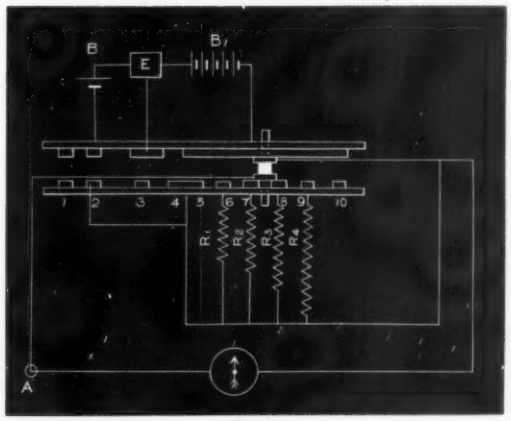


Fig. 3.

and short-circuited as before described, and the cable "rung off." When the next cable or wire is ready for testing, the switch lever is put to position 2, and the preceding operation gone over again. If, however, earth readings are required to be taken at the end of the last minute's electrification reading, the switch lever is rapidly put to position 4, the cable being thus discharged, and the galvanometer cut out; after a few seconds the lever is put to 3, the necessary shunt being inserted and the readings taken. The switches are made with A F of any resistance value, the values, R_1, R_2, R_3, R_4, being $\frac{1}{10000}$th, $\frac{1}{1000}$th, $\frac{1}{100}$th, and $\frac{1}{10}$th of the total resistance, A F, the multiplying power of the shunts being in accordance with those values.

The practical directions for operating the switch may be briefly put as follows:—After having connected up the switch to battery, galvanometer, and earth as directed on its face—

To Take Capacity Constant.—Connect standard condenser between A and earth, move lever to 2, after to 3, and note deflection; multiply by shunt value, if any is used.

To Take Insulation Constant.—Connect standard megohm between A and earth, move lever to the right until maximum possible deflection is obtained, multiply deflection by shunt value indicated. If, however, standard megohm is not at hand, note deflection through 10,000$^{\omega}$ or other convenient resistance with one cell placed at B, compare number of cells in testing battery by means of condenser connected as for capacity measurement, then constant

$$= \frac{a \times b \times \gamma}{10^6}$$

Where a = deflection obtained with one cell through γ ω.
b = number of cells in battery, B, in terms of the one cell.
γ = ohmic value of resistance.

Cable Testing.—Connect cable or wire to A, the insulation of which is required; move lever to position 2, after to 3; note discharge deflection; continue movement of lever to right hand until the largest readable deflection is observed on the galvanometer scale, multiply this by the shunt value shown at indicator, and divide this into the constant which gives the insulation resistance of the cable in megohms.

In the switches now made by Messrs. Nalder Brothers, the general design is somewhat modified. The handle to actuate the lever is put at the base of the instrument, and consists of a large ebonite milled disc, and the connections on the inside are made damp and dust proof by a strip of ebonite connecting the two arcs.

This instrument has been found of great utility in portable testing sets, the fact that all shunts, &c., are automatically inserted by the one movement of the lever, and their successive automatic insertion from $\frac{1}{10000}$th value downwards on each test, rendering the damaging of the galvo by a faulty cable practically impossible.

THE REACTANCE SYSTEM OF ARC LIGHTING.*

By WILLIAM SMITH HORRY.

I.

It cannot be denied that there is some room for improvement in arc lighting. The numerous and comparatively small dynamos, each supplying its own line, is quite out of place in a large arc light plant, and these besides being theoretically inefficient, give more trouble and take up more room than would one or two large generators each capable of supplying a whole city in a business-like way. Our other electrical industries have all been greatly improved by the systematic use of large and efficient generating units at the station; the series arc lighting system alone has been left unimproved in this respect, and this industry may therefore be looked upon as being still in a state of transition.

It would be difficult, in the present state of the art, to design an arc light station capable of the lighting of a large city, in any way comparable for economy to, say, an incandescent lighting or electric railway plant; for the reason that our manufacturers have not yet given us a comprehensive system of arc lighting. What we have now is good as far as it goes; our half-acre of dynamos, &c., is all very well, but surely something better is coming.

It must be admitted that the alternating arc lamp has done much to settle many problems connected with the supply of commercial arc lights; its introduction has been rapid and satisfactory, and it bids fair to become more used in the future as its economy becomes more appreciated, but for street lighting with transformers there are still some hindrances to its use, and at present the series system is the only one that need be considered for this class of work.

II.

A method of working arc lamps in series from the primary circuit of alternators without using a transformer, resistances, fuses, &c., to each lamp, and which is quite comprehensive enough for modern times, since a whole city can by this method be lighted from one machine, may be deemed of sufficient interest to warrant this description. The generator employed is the ordinary alternator that we are so familiar with in transformer lighting, and the lamp is also the ordinary constant potential alternating arc lamp; and neither is changed in any way, so that different types of lamps, as of dynamos, are unnecessary. One lamp, and that of the most simple construction possible, is substituted for all purposes.

The type of lamp alluded to has already been brought to a high state of perfection, and it is, moreover, the most simple and elementary lamp that can be conceived. It has but one solenoid which is in series with the arc, no shunt spool, no cut-out, and is very reliable in consequence of having so few parts. These can now be procured in such sizes as to run for as many as 16 hours on this system without new carbons, and all-night lighting with this lamp becomes a fact.

If a choke coil, properly designed, be placed across the terminals of such lamps as these, arranged in series, each lamp will be found to regulate perfectly if the voltage at the end of the series be kept constant. The lamps, if of 1,200 C.P., will be found to take about 30 volts each. The choke coil need only be a small one and need weigh but a few ounces. It consists of a little core of highly laminated iron wound with wire in such a manner that the passage of even a small current will magnetise the iron very highly. The arrangement is shown in fig. 1.

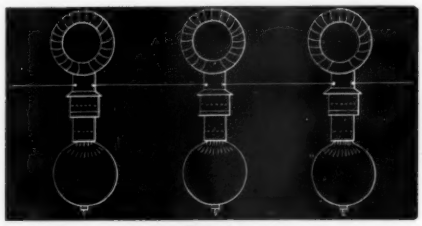


Fig. 1.

For practical work, however, thick wire must be employed, so that when the carbons are all burned away, the winding will take the whole lamp current continuously without injury to itself. Such a coil fitted to a lamp of 1,200 C.P. will weigh about three pounds.

III.

Upon this principle the "Reactance System" of arc lighting has been founded and so named because the reactance of a secondary or derived circuit causes the regulation of the lamp which is installed in series with others in the primary line.

The precise mode of operation is radically different from any other system. We have a line of many arc lamps in series, so that there is to all intents and purposes a constant current passing. Each lamp has a choking coil across its terminals, in shunt with the arc, so that there are two paths for the current, one between the carbons and the other round the impedance coil. With only a few volts difference of potential at the terminals, the current will be all choked out of the coil and all will pass through the arc, it lighting up the lamp the instant the current is turned on. As the carbons burn away the voltage at the lamp terminals will

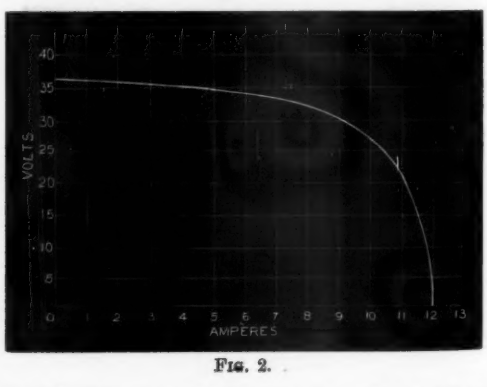


Fig. 2.

rise and the little coil will begin to leak. The impeding or choking power of an induction coil breaks down as the iron composing its core approaches to magnetic saturation. The result is that the arc is robbed of some of the line current and therefore the lamp solenoid releases its hold on the carbon and causes the lamp to feed. It is found in practice that this device is very thorough. It takes care of the lamp whatever happens—makes it start up at once, keeps the voltage on the arc constant, and the lamp carbons may be open-circuited or short-circuited without any damage accruing to either the lamp or the line.

* New York *Electrical Engineer.*

IV.

These are new effects in series arc lighting. There was never before such a controlling device, which containing absolutely no mechanism, yet at the right time performs the functions of a starting box, transformer, shunt solenoid, automatic cut-out, and line compensator, and which is possessed of all the qualities necessary to perform each of these duties at the right moment and with unfailing certainty.

To give an idea of the current that passes through an arc lamp when this regulating coil is employed in shunt with it, a table is given below and a diagram, fig. 2, illustrates it graphically.

Ampères actually passing through the arc.	Volts at terminals of lamp.	Observations.
12	0	Carbons touching.
11·2	20	
10·8	25	
10	28	Lamp working properly.
9·4	30	
9	32	
0	36	Carbons separated.

These measurements were taken on a line of 35 lamps arranged in series as in fig. 1, working at 133 ~ from the primary circuit of a 1,000 volt alternator. The line current in this instance was 12 ampères. It may be remarked that in this case it was necessary to employ a 12 ampère line, as by this means the lamps started up very perfectly, and never failed to burn.

The line adopted in the "Reactance" system, however, is generally 10 ampères, and a diagram of the circuits is shown in fig. 3. In this way a 2,000-volt alternator will run 60 lamps in series each of 1,200 C.P., though in practice, over 8 miles of No. 8 wire, it was found that only about 52 could be run in one series.

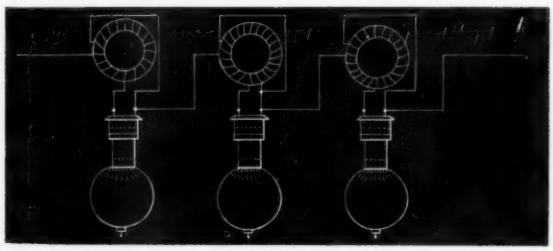


Fig. 3.

The system is automatic over a very wide range. Thus, if in a line of 30 arc lamps, five are extinguished in consequence of the carbons having all burned away, the remainder will run on just the same, and the ampèremeter at the station will not be sensibly affected. This automatic regulation is a very good feature of the system and it amounts in practice to 33 per cent. of the lamps for which the line is adjusted.

V.

The efficiency of the device may be dismissed with a very few words. The ampères that flow through the coil are almost entirely wattless, and the whole device is exceedingly efficient. A wattmeter measurement shows the coil to consume about 7 watts and small though this may appear, the measurement has been taken again and again, with the most perfect instruments, with the arc lamp working, and its correctness is beyond question. This applies only to the coil employed with a 1,200 C.P. arc lamp; with a full 2,000 C.P. arc lamp the loss is about 40 watts, because in the case measured, the arc regulating coil had to act as transformer as well. The iron in the core of course gets hot, and for this reason only very little iron is employed —highly saturated.

The switchboard employed with the reactance system is shown in fig. 6. It consists of an ampèremeter and a pilot lamp—10 ampères, a double-pole switch, a fuse block, and a series of contacts for throwing more or less impedance into the line. Lamps of 1,200 C.P. are installed as in figs. 4 or 5, but larger arcs are generally fitted as in fig. 4. It may be pointed out that lamps of widely different power can be connected in the same line, and that though the voltage on a 1,200 C.P. lamp is about 30, the larger arcs work better with less, say 24, and that only on this reactance system is it practical to give each lamp the voltage best suited to its needs at all times.

But the most important item of all, more important even than high efficiency—is certainty of operation. In this respect the "Reactance" system leaves nothing to be desired. The coils cannot burn out, as they will take the whole lamp current without injury; lightning cannot hurt them. There

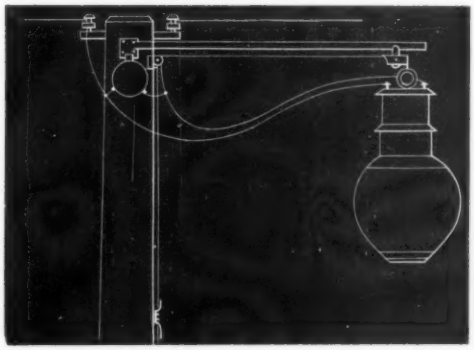


Fig. 4.

are no fuses to blow or to attend to. Altogether, the system is as hardy as it is possible for it to be. It is also possible by this system to use a carbon of great length and to regulate it so that the length of the arc is invariable, whether these carbons be just lighted or nearly all burned away; and the arc regulators being so small the period makes little difference. A little larger core is all the change necessary for a regulator to work with 60 ~ instead of 133 ~.

It is obvious that any number of lamps can in this way be run from one alternator. Step-up transformers can be employed to run 100 or more arc lamps on one line or with two lines double that number. For indoors one large building is lighted with 10 arc lamps supplied as in fig. 5, from a transformer secondary circuit of 300 volts.

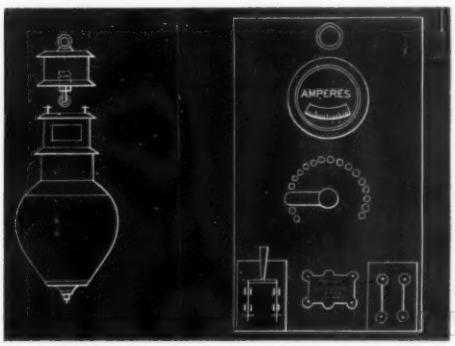


Fig. 5. Fig. 6.

This greatly simplifies the wiring. The system works equally well on a constant alternating current dynamo or on a constant potential machine, and the lamps can all be worked on the secondary C.P. circuit if necessary in the ordinary way.

It is considered a great gain to dispense with the cost of transformers for street lighting and it is hoped that when the extreme economy of the "Reactance" system is appreciated it will be found to be an improvement on existing practice and a step forward in the right direction.

ELECTRIC LOCOMOTIVES.

In reading a paper on "Electric Locomotives" before the Manchester Association of Engineers, Mr. Edgar Worthington referred to the fact that he had had something to do with the engines of the South London Railway, and had studied electric railways in many countries. Mr. Worthington's chief experience has been in steam locomotives, and it is satisfactory to find one of so conservative a class of men so open minded as this paper clearly shows our author to be. Reviewing the history of electrical traction, it is stated that the first commercially successful electric railway only dates from 1886, when there were only some 12 or 13 lines in the whole world. Boston (U.S.) did not possess a line until 1889, yet in 1893 could drive 640 cars from one central station, and Americans had been the boldest experimenters in electric traction. Historically, the earliest electric locomotive was made by a village blacksmith in 1835, and did not differ materially from present day types. One of them was even brought to England and seen by Faraday, who, however, refused his recommendation because he was able to stop it easily with a broom. When the author visited America in 1881—3, only one electric line of any moment was in existence—that at Richmond on the Sprague system, but it ended in failure. Since then, the great growth of lines has been chiefly on the overhead trolley system, and in 1893 there were 13,000 miles of electric railway in the United States, and only some 440 miles in Europe. The largest of the European lines are the South London, using 1,200 kw., and the Liverpool overhead line, using 900 kw. In the United States, a daily car mileage per car of 150 to 200 is sometimes reached. The Leeds Tramway car mileage per car sometimes reaches 110 per day, while the cars of the Halle Tramway, one of the best equipped in Germany, run only 71 miles a day.

It is stated that financial experience shows that electricity is not likely to supplant the cable for crowded traffic, or the steam motor for infrequent service, but that its special traffic is that of moderate dimensions. As regards power of acceleration, this is not now wanting in modern electric motors. At San Francisco, where coal is lifted 60 or 80 feet by electric cranes, it is hauled away by locomotives with a draw-bar pull of 800 lbs., and the load variation on the dynamo rises from 0 to 75 per cent. of full load in 5 to 10 seconds, and again drops in the same time. Summarising the advantages and facilities of electricity in town and suburban traffic, these are given as follows:—Comfort, speed, cleanliness, lighting, heating, ventilating, and, perhaps, soon to follow, an electric brake, which will give back 40 per cent. of the energy it absorbs.

From a mechanical standpoint, a railway motor must have a large torque, to be obtained by a large number of windings in the armature, whereby, also, are diminished hysteresis and eddy currents, and an absence of sparking and heating. Mr. Parshall has said that heavy magnetic induction is aimed at, there being—

100,000	C.G.S.	lines	of	force	per	square inch of yoke.
60,000	"	"	"	"	"	air space.
80,000	"	"	"	"	"	armature core.

A motor ought to be economical when lightly loaded, for their average work is but 20 per cent. of their maximum starting duty. The gearing of an American tram motor has, says Kennedy, an efficiency of 75 per cent., the difference between a geared and ungeared motor being 17 per cent. Other authorities give 80 per cent. efficiency in good single-reduction motors, and the Westinghouse Company profess an efficiency of 92—96 per cent. under full load. In double geared motors, as between armature and axle, 60 per cent. was rarely to be obtained. Practically, in America, the Westinghouse Company and the General Electric have absorbed all the smaller companies, and the standard motors of to-day are much simplified and reduced in cost; the armature has a core of soft iron discs, and in place of paper insulation, Foucault currents are prevented simply by a black oxide coating, formed by heating the discs, which are simply punched out of plate, threaded on a spindle, compressed and finished by power-filing the rough-punched winding notches on their rims. The armature, thus completed, revolves within $\frac{1}{10}$th inch of the magnet poles. Much of the lighter work is done by women, both at Lynn and Pittsburgh. There are usually four poles cross-connected, so as to require but two sets of brushes. Pole pieces are steel castings with ·18 carbon and but little Si. Mn. or P. Motors are series wound, and have carbon brushes. The spur wheel gearing is milled out of the solid, and the whole motor is cased in a box close enough to allow a car to run through water, which the author has seen nearly up to the axles.

As regards the requirements of a motor, there should be lightness, tightness to water or dirt, accessibility, a power to run two hours at nominal rating without heating above 122° F., and a capacity of developing an excess of 50 per cent. above rating on an emergency. A modern motor of 20 H.P. weighs 800 lbs., with its single reduction gear. The direct motors of the Liverpool line weigh 52 cwts.; the new large motors of the Baltimore Tunnel weigh over 11 tons, entirely supported by springs. In the Heilmann engine the motor weighs 2·7 tons, and is carried on the frames. Lightness is essential, and in all cases the armature and magnets must move together, if the armature is to maintain uniform clearance.

Referring to starting power, Mr. Worthington expresses his doubts as to American figures. He thinks that the Chicago tests of street motors in 1893 were useless, the competitors sanding the rails, and using other devices, to obtain grip while registering a maximum tractive force by dynamometer, secured by what he looks on as tricky manipulation of the current.

The 95-ton Baltimore engine is rated at 1,800 H.P., but he doubts the daily practice, and states that the traffic is being worked *slowly* to-day by these engines. Regulation is effected by a barrel switch, the barrel carrying metallic strips as arcs on its surface, and sparks being "blown out," as they tend to form, by an embracing magnet. In a pair of 30-H.P. Westinghouse motors, this barrel switch has seven positions, as follows:—

1. Starting with 500-volt current passing through both motors, all in series.
2. As in 1, with half the resistances cut out.
3. As in 1, with all resistance cut out.
4. With reduced magnetic field.
5. One motor cut out.
6. Both motors, but run in parallel without resistance.
7. As 6, with reduced field.

The resistances are spiral rolls of tape iron, mica insulated, and they often get red hot. There is a separate reversing switch.

As regards the work of the machinist to be put on an electric engine, there is little need of this. Having no reciprocation, there is little need of careful fitting, and no tendency to knock at the axle box guides, &c. The picking up of current is next discussed, and the inconveniences arising from want of a return wire. For fenced in lines, the third rail, as at Liverpool, or in the City line, is obviously the proper thing. Conduits have their many well-known disadvantages of dirt and wet, unless closed, and contact assured on the surface by means of magnets, which raise the conductor against the sections of surface strip. Schuckert found heaps of iron filings to make contact more surely and easily, and Edison is said to be developing a system in which a current of 1,000 volts will be transformed at intervals into 20-volt currents in sections of the rail itself. At this point Mr. Worthington delivers judgment upon the "unsightly posts and overhead wires of American cities, which it would be a blessing to remove." It almost looks as though he took his ideas of the overhead system entirely from some of the cruder installations of America, and had given no heed to their better lines, or to our own lines, such as Bristol. As regards fire escapes, we might again ask, is it necessary that these should be run vertically through the streets?

Four types of electric locomotive are named, to wit, those with storage batteries; with gearing and picked up current, and the same direct driven, and *mirabile dictu!!!* the Heilmann!! We should scarcely have thought that an engineer of Mr. Worthington's experience would have cared to class the Heilmann engine at all. However, he does so, and even gives his hearers to understand that it has been worked successfully on several main lines of French railways, to which statement we would like to ask when? and where? for he says it has run regular trains at high speeds. To us this travelling central station seems the height of

absurdity. Granting all that can be claimed for the use of highly economical engines, it will take a good deal of economy to make up for the complication, expense, and inconvenience of the system, in face of the fine results obtained with ordinary or compound steam locomotives, while for the very class of high speed traffic specially claimed for the Heilmann engine, the ordinary locomotive with its then high rotative speed cannot be surpassed. Mr. Worthington does not absolutely uphold this engine, but his criticism is very mild drawn indeed, even when we consider that parts of the new engines are being made by the Manchester firm of Beyer, Peacock & Co., with whom, we believe, he is connected.

We would merely note that while the engine weighs 120 tons, it drew a train of 63 tons at an average speed of 43·75 miles per hour for 50 minutes.

Storage battery locomotives have had a limited application in New York and in Paris, and have run 23 miles on one charge in tramway work, the batteries giving up 70 per cent. of their charged energy. A French railway company, the Paris and Lyons, built, in 1893, an accumulator driven engine of 246 H.P., carrying batteries itself, and hauling also a further supply in a tender of 44 tons weight, but this railway has now abandoned its experiments.

Altogether, we should say that no very great showing has been yet made in accumulator work.

In geared motors with underground conductors, the 10 years' success of the Blackpool line is notable. We well remember our ride on the first of Mr. Holroyd Smith's lines, a few yards in length, laid in a Halifax garden.

Gearing by pitch chains has not been a success, though it affords the advantage of removing the motor weight from off the axle, but the chain gets dirty and dusty. Coupling rods have been tried for the same purpose, but these, again, introduce the objectionable reciprocating stresses, and the necessity of engine fitting, and coupling rods have thus not come into favour. Worm gearing has been tried, but though it allows of a small motor doing a heavy duty, it is only used for small speeds. We remember, however, that worm gearing ran exceedingly well on the steam tramway engines of Wilkinson, in Wigan, and they certainly could not have been large producers of friction, because, in running down hill the worm wheel on the axle actually drove the worm, and of course the engines themselves, easily and smoothly. Wilkinson's worm and gear were very nicely made, and we well remember that he had every faith in the appliance, and he was undoubtedly a very able mechanical engineer. Double spur gearing has been used for the same end in freight work, but, except for slow-moving machines, it is unsuited by reason of jar and teeth breakage.

Various engines have been made with double reduction motors, some with the gears in an oil-tight case, but by far the larger number of electric street motors are of the single reduction, 4 or 4½ to 1 gearing, the teeth being all cut from solid blanks.

In one day in October, 1893, 11,271 car miles were run by Chicago cars on 26 miles of line, and 208,575 passengers were carried. The average voltage the day through was 540 for 20 hours, the flow was 1,050 ampères, and the maximum was 17,000, the coal consumed being 23 tons. This works out at about 4 ounces of coal per passenger. Of English-built lines on the system are that at Leeds, Dublin, Bristol, and Hobart Town.

Of direct-driven motors, one of the earliest and most successful is to be seen on the South London line, where two axle engines of 10⅓ tons carry on each axle half a ton of field magnet dead weight, in addition to the armature. One end of the field magnet is carried on a girder across the frames. The power is 50 horse, at a speed of 25 miles, and the current varies between 50 and 100 ampères, occasionally reaching 150, with a maximum tractive starting effort of one ton or more.

In the Nantasket Beach line the voltage is 700; the biggest engine has a motor of 100 H.P. on each of four axles, and a draw bar pull of 8,000 lbs.; but the largest American locomotive is that at Baltimore, before referred to, and designed to haul a train through tunnels on the Baltimore Belt line for sake of ventilation, which, however, is a little spoiled by the present practice of hauling smoking locomotives also through the tunnels. So far, these electric locomotives are not credited with any brilliant success, but it should be noted that the mishap with the picking-up shoe was rather due to mechanical defects, and can scarcely be urged against the system. The Baltimore engine will overpower a steam locomotive of equal adhesion, owing to its regular torque; but this, of course, is not a matter of very great moment, and of no moment at all when speed has been attained. Schemes—merely promulgated, and never carried to fruition—are briefly noted, and need not be further referred to by us.

As regards cost of electric lines, the experience of America is to the effect that the initial cost of power-house generators, car shed, motors, and accessories, runs to £1,000 per motor car, and permanent way complete, except for paving, to £2,000 per mile of single track. Including paving, the permanent way alone, without pole line, will cost £4,393 per mile of single, and £9,440 per mile for double line, with 78 lbs. step rail.

Expenses of running are apt to decrease with age. On the South London line they fell from 8·4d. per train mile to 5·31d. in 1893, by which time the cost per B.O.T. unit was 1·56d., including office expenses. An American estimate of operating cost of six miles of double line per 16 hours' day is 7d. per train mile, and generally an electric and a cable line have about equal operating expenses. As an illustration of three types there are given the City of London electric line at 5·31d., the Frankfort horse line at 8·02d., and the Birmingham steam trams at 7·31d., while the Halle electric line, at a fare of 1½d., has a working cost of 59 per cent. of receipts, and pays 5·1 per cent. dividend. In Boston a car mile rate of cost of 1s., as with horse cars, has been reduced in populous districts to 6d., and even 4d. Summing up, we are glad to say that the paper is favourable to the future of electric traction, and we think the author is right in emphasising its sphere as that of the light suburban passenger traffic. Indeed, so far, we are not disposed to quarrel with him in showing up the doubtful status of what we would term the more ambitious schemes. We are no believers in the early death of steam traction, but we do strongly believe in electric traction in its own peculiar sphere, and the author of this paper seems to be very much of the same mind, for he considers it would be wise of the railway companies to develop electrical traction on feeder lines in thickly populated districts, or otherwise, they will find themselves face to face with competing electrical lines that will deprive them of much traffic. As a whole, the paper is very good, but not an easy one to abstract.

It is a very fair historical statement of the electric traction movement, which has attained so great a growth in the few years of its life. At the same time, in its figures of American progress it affords great hope of what we may expect when the antipathy to overhead systems has been overcome by a few more cases like Bristol. When such a growth of electrical traction does come upon us it should not prove an unmixed blessing that there has been so much delay. England constructed her steam railways much as America has built her electric lines, and the result has been in many respects far from advantageous, because of the limits set upon extension by the primitive construction suited to the earlier rolling stock. America had the benefit of a fuller experience at our expense, and it looks as though a sort of reciprocity were now about to be set up. We may look on the paper as some indication of the attitude of the more liberal type of steam locomotive men towards the newer form of traction. The Manchester firm of Beyer, Peacock and Co., has, in a sense, paralleled that of the Baldwin Company, of Philadelphia. The latter firm have joined with the Westinghouse Electrical Company in forwarding, to some extent, the interests of electrical traction, and Messrs. Beyer and Peacock have done somewhat similarly on this side, and will doubtless reap considerable benefit in due season from their forward step.

New Book on Submarine Telegraphy.—Mr. Emanuele Jona, an Italian engineer, has recently written a book on this subject, entitled, "Cavi Telegrafici Sottomarini." This is the first book of the kind ever written in Italian, so far as we are aware, and we shall hope shortly to be able to give a review of it.

D

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

The "Electric Wiring Question." By Fred. Bathurst, Associate. (Abstract of paper read November 28th, 1895.)

The "electric wiring question," which is the subject I venture to bring before you to-night, is one in which each individual member of the electrical profession has directly or indirectly more than a momentary interest.

Moreover, in view of the contemplated issue of a new set of "Wiring Rules" which will bear the imprimatur of this Institution, it is at the present moment worthy of careful consideration.

With the information and experience which has been accumulated in the past 12 years, we should now be in a position to lay down rules which will advance the art of wiring towards perfection. Such rules should not only conserve the welfare of the public, but should also regard the interests of the electrical industry.

My object is to ask that, in any consideration of this question, due recognition may be given to the use of an *insulating tube* as one of the factors which must enter into the question of perfect wiring.

Hitherto the ordinances issued in respect to wiring have had for their primary object the prevention of fire, and have, therefore, received the general designation of "Fire Rules." These rules have been rigorously administered under capable, indefatigable, and impartial inspectors connected with the various fire insurance offices. No question can be made as to their efficacy in respect to the prevention of fire, but I submit that, considered from a technical and economical standpoint, they cannot in any way be regarded as ultimate or final.

Electricity, in respect to its utilisation, should not be tied down to specified lines and methods which hamper its proper development and progress.

Perhaps I may be pardoned a momentary digression to outline briefly the electrical progress of England as compared with some other country. Let us take the country typical of progress—America. Both countries were in 1881 on the same basis; the apparatus was crude, experimental, and imperfect, and the knowledge in respect to the safe and proper handling of the apparatus employed was limited, and possessed by but few people. In England in 1883 the possible dangers began to attract attention, and rules and regulations were issued which were to control development and progress. In America no regulations were enforced; for good or evil, a normal development held its course. The American knew his imperfection, but his utilitarian instinct forced him to employ any means at hand by which to gain further experience.

Oftentimes absolute security may have been sacrificed to the necessity of the moment. The American public, however, demanded the new light, and it had to be installed at prices which did not always provide for solidity and permanence.

It is just here that insurance authorities may ask about electrically caused fires. If so, I seize the opportunity for removing what appears to be a greatly exaggerated apprehension. The hurriedly installed apparatus did cause fires, and in a measure terrorised the public much in the same way as our recent subway explosions in London alarmed the British public. Gradually, also, the American fire insurance offices took alarm, and "Rules" began to see light. Different States had different regulations, and each inspector became a "law unto himself." Utimately it was seen that "confusion had become worse confused," and that effort must be made to produce rules which would be generally acceptable.

Within the last few years the underwriters determined to appoint an Electrical Bureau to collect information concerning the fires said to be "caused by electricity," in order that some general deductions could be made. The reports issued by the Bureau (under the effective direction of W. H. Merill, jun.) are most comprehensive, and give valuable and instructive information in respect to the electrical fire hazard.

Taking 1893—1894 as two typical years in which public alarm was prevalent in America, reference to the records shows the occurrence yearly of between 400 and 500 fires traced to electrical causes. Some 320 involve no monetary loss, but the remainder (100 to 200) result in a loss of £300,000 per year. This sum, though apparently large in itself, is less than 1 per cent. of the total fire loss of some £35,000,000 from all causes.

In fact, the insignificance of the danger from commercial electrical application is best shown by comparison with the loss caused by Nature's wayward electrical illumination—lightning. Taking the figures from the United States Government records, I find from the average monetary loss per year, for nine years ending 1893, that "lightning" involves a loss of £310,000 or some £10,000 per year more than that caused by the commercial use of electricity.

At the present time America has the benefit of numberless motor applications, and over 8,000,000 arc and incandescent lamps, against, perhaps, 2,500,000 in England.

Can I not, therefore, argue that restrictions of one sort or another have hampered the proper development of our electrical industry?

The insulation on the wires has changed from paraffined cotton to a durable rubber covering. Not only has the quality of material been enhanced many times, but, with it, market values have fallen so as to be on something like a permanent basis. Central supply stations have been built, and methods of generation and distribution so improved that electricity can be supplied, light for light, at prices directly comparable with gas.

Up to the consumer's premises we have economical electrical production and distribution; and, notwithstanding the expense of the initial installation within the house, a demand for the light has grown. The recent rapid growth of municipally owned electric supply stations would even prove that it is becoming an actual necessity. Why, then, is it that in England, the most prosperous country of the world, this light—the safest and best illuminant—is not making the same rapid headway and progress that it is doing amongst less favourod nations? This, in fact, is the "burning question," which I shall endeavour to make as important as that "question of burning" of the fire insurance companies.

Even if it is contended that we are, as a whole, making sufficiently rapid commercial progress, no one will dispute the statement that, commercially considered, the state of affairs with our "wiring contractors" is, to say the least, *bitterly disappointing*. The bare mention of the fact that for the same piece of work tenders may be received which vary in respect to one another by one, two, or even three hundred per cent., is in itself sufficient to show the conditions obtaining in this direction.

The principal obstacle to the general use of electrical applications is that under our present wiring rules it is impossible to place the cost of installation within reach of the great bulk of our people. The largest number of consumers to whom we cater—the middle class—cannot afford the initial outlay necessitated by adherence to our present methods.

I submit, therefore, that what is still required is the introduction of rules and regulations which will facilitate the growth of "lower cost wiring." Nothing is further from my intention than to advocate cheap, defective, poor, or dangerous wiring. But, speaking as one whose wish is to promote the welfare of our industry, I suggest that the time has arrived when the advent of "wiring methods" which will reduce the first cost of electrical installation to the general public by perhaps one-half that now obtaining, will, if rightly ordered, give to electrical activity, with its inherent possibilities, that impetus which we all know it to be capable of receiving.

With "lower cost" wiring we could, for instance, successfully compete with the lately introduced "incandescent gas burner," which, priced at about 13s., has had a sale amounting to three-quarters of a million.

It is being recognised that the ruling factor which governs public demand is small initial outlay. Even the gas companies are facing the question of fitting consumers' premises free, and reimbursing themselves by charging a slightly increased price for the gas supplied.

Let us consider briefly the essential features of good wiring. The five cardinal points may be given as safety, durability, convenience, accessibility, and economy. It is my belief that all these requirements can be met by the use of *fire-proof insulating tubes;* but before dealing with this point I may be permitted to challenge the existing methods in the light of these requirements.

As the advocates of "concentric wiring methods" are, I understand, to present their views, courtesy leads me to avoid any direct criticism of "concentric" systems, except under those general headings in which they could obviously be included.

It will probably be admitted that wood casing fails in many respects. As a "mechanical" protection for the wires it is imperfect; and it is as deficient in "insulating" protection, because it is neither damp-proof nor incombustible. In concealed work it is positively an obstacle to the development of electric wiring. It shrinks and warps, causing plaster to crack, and often necessitates costly redecoration. On account of its one desirable attribute—accessibility—it may survive somewhat longer for surface work.

If surface work is required on the score of economy, surely it would be better to adopt "open work" on porcelain insulators—a safe and scientific method of wiring, which can be carried out at a very much lower price. We know this system is discouraged; but it is noteworthy that in the only prominent installation in this country where "open work" has been used, the single source of trouble which occurred arose on a circuit in a damp cellar, where, in order to conform with the fire office "requirements," *wood casing* had been employed. Someone may argue that this could not have occurred if the circuits had been "tested" as the "Rules" recommend. This statement I will answer by a question. It is, whether "insulation resistance" as now specified is not, after all, somewhat of a myth?*

Our "insulation test" never yet told far into the future, and it only tells the present to a limited extent.

"Insulation test" cannot discover an unsoldered joint or a dangerous diminution in respect to current-carrying capacity. Every practical man will agree that insulation testing will not necessarily indicate that the wires are at places in dangerous proximity to gas or water systems in event of moisture appearing.

To continue, the recognised shortcoming of wood has brought into use iron and "lead compo" piping. Lead compo pipes afford but little mechanical protection in emergency, and, with respect to "accessibility," have serious drawbacks on account of their flexibility.

A large amount of "surface leakage" necessarily arises from the use of any ordinary metal tubing. Moreover, if the insulating material on the conductors has from any reason deteriorated and moisture appears, there will be consequent injury both to conductor and tube. Cases have occurred where the protecting fuses on a circuit did not "blow" before electrolysis promoted a dangerous arc which had burnt a hole in the tube and presented a serious fire risk.

If a defect occurs anywhere in the insulation of a wire which is within a metal pipe so that there is electrical contact between the conductor and the pipe, the effect of the fault is virtually transmitted throughout the whole length of piping, there to await or invite trouble elsewhere. With two conductors in the pipe a new and unanticipated electrical condition prevails, because one conductor is now of greater carrying capacity than the other, which has been increased by the capacity of the tube itself. Overheating of the intact conductor can now invite serious trouble at any point. This, I think, explains why overloaded wires in pipes have occasionally "burnt out" at several points at the same instant. It must not be

* See Appendix B.

forgotten, also, that failure of insulation on one wire means that the voltage tending to break down the other is doubled, and the actual strain (C^2 R) increased fourfold.

Perhaps at this point, already, it will be noticed that my criticisms show, incidentally, how much more our immunity from electrical fires has depended upon the honour and integrity of our contractors than upon the "rules" provided for their guidance.

Iron pipes have the disadvantages common to all metal pipes, and, as we know, may rust inside, and this rust is not a condition favourable to "insulation;" they often have burrs or other internal roughnesses which may cause serious mechanical damage to the insulating material as the wires are being drawn in. If iron pipes are screwed at the end for the purpose of jointing, oil is probably employed, and any excessive presence inside is not helpful to a rubber insulation. Cases are on record where this oil has caused extensive mischief.

Early in the art of wiring it was recognised that gas brackets, when modified so as to serve as "electrics," should be insulated from the remainder of the gas piping; but now that we are using electric wires themselves in metallic pipes, we appear to overlook the possibility of the electric system being elsewhere in hazardous contact with conjointly installed steam or water systems.

It is now apparent that metal pipes, if not actually harmful, are certainly not particularly helpful to the maintenance of insulation resistance.

As thrifty business men we must recognise that when buying electric wires we are paying for *insulation*. It is true we require the copper for current-carrying capacity, but in a high-grade wire the expense of the insulation is about twice that of the copper.

From the commercial aspect, apart from any technical considerations, the cost of a metal pipe is a formidable drawback. The usual clause dealing with the protection of "conductors" says "they must be enclosed in substantial wood casing or *approved* metal tubes." If this refers to iron or compo pipe, and we are to adhere to the regulation, how can we compete with the gasfitter when we have to supply the pipe as well as the insulated wires inside it?

It may be thought that we must turn away from tube or pipe methods altogether in order to find economic wiring. Experience in other countries, however, does not show that any "rigid" system of conductors is making progress or headway. No insulated wire has yet been produced which in itself can successfully resist the deteriorating influences present in mortar or plaster. Even lead-covered insulating wires, if directly embedded in plaster, have been found wanting, and give trouble from "earths" and "short-circuits" as soon as moisture has made an appearance.

With any rigid method, if walls happen to crack and settle, or plasterers and bricklayers cause damage, a fault may develop which is very difficult to find. Usually, also, they are handicapped commercially in respect to making joints and connections, as these involve risk and trouble even with the highest quality workmen.

A cardinal objection to "rigid" methods is the lack of accessibility. All good wiring should be accessible, for with this quality assured half the difficulty of "trouble" is already fought, and any imperfection or injury, whether arising from poor work, negligence, or accident, can be remedied with a minimum of inconvenience.

A conduit or race-way is the practical way of rendering wires "accessible," for then the wires installed in them are always open to the inspection of owner or wireman, whenever he wishes to satisfy himself as to their condition or to effect a renewal. "Accessibility" ought, therefore, to be a fire office requirement;" * with it an inspector can use his *eyes*, and have no need to trust to his *ears* for inspection.

From the contractor's point of view "accessibility" is desirable as limiting unfair and injurious competition; for, when an installation can be readily inspected, inferior materials cannot be used for the purpose of cutting down prices, workmanship cannot be scamped, and the "death knell" of unprincipled competition could be sounded for all time.

This brings us to the consideration of the conduit itself. From a labour-saving point of view a flexible conduit would apparently commend itself. Whilst cases do occur where this is true, every flexible conduit has the inherent drawback, as shown by experience, that the property of "flexibility" may so far assert itself that numberless bends will prevent the wires from being drawn out. Any trouble which then occurs will have to be cut out, or else the circuit must be abandoned or wired anew. Flexible conduits are always at a disadvantage either in respect to moisture-resisting properties, or are wanting in mechanical strength.

Bends and elbows must be *rigid*, or it is impossible to draw the wires in or out; and for the generality of work it will be found that a conduit construction permanently rigid throughout is preferable.

I have already pointed out that more than half of the cost of the wire we use is referable to "insulation," and that it is "insulation" we strive to keep. It would, therefore, appear obvious that the conduit should be an "insulating" one. An ideal insulating tube should not only be mechanically strong, but also fire-proof and waterproof. With a tube complying with these requirements, all possible electrical trouble is minimised, the insulation on the conductors themselves is protected from mechanical damage, and is enveloped in a preservative, rather than a destructive element. Temperature changes are reduced to a minimum, and, if the conduit resists acids, alkalies, and gases, the insulating material on the wire is so shielded that its life is indefinitely prolonged. It appears to me that the insulating tube does for "wiring" what the high-resistance incandescent lamp did for the "distribution" problem.

I contend, therefore, that an insulating tube method of wiring will prove the ultimate solution of the "electric wiring question."

[Here Mr. Bathurst, risking the criticism of "advertising," as he puts it, described in detail the system of the Interior Conduit Company's system, which was copiously illustrated in our issue of May 24th last.]

* See Appendix C.

APPENDIX B.

TABLE SHOWING THE "INSULATION TEST" REQUIRED IN VARIOUS COUNTRIES.

(Compiled from Rules of Supply Companies and Fire Offices.)

Voltage of Circuits not to exceed 250 Volts.

Size of installation, wired complete.	Country.			
	England (London).	America (New York).	Germany (Cologne).	Austria (Vienna).
Ampères.	Ohms.	Ohms.	Ohms.	Ohms.
10	500,000	2,000,000	100,000	50,000
25	250,000	1,800,000	40,000	20 000
50	125,000	400,000	20,000	10,000
100	—	150,000	10,000	5,000
200	—	80,000	—	—
250	25,000	—	4,000	2,000
400	—	40,000	—	—
500	12,500	—	2,000	1,000
800	—	11,000	—	—
1,000	—	—	1,000	500
1,600	—	5,500	—	—

APPENDIX C.

RESOLUTIONS ADOPTED AT THE MEETING OF THE UNDERWRITERS' INTERNATIONAL ELECTRIC ASSOCIATION, CHICAGO, AUGUST 17TH, 1893.

Whereas, under existing practices, but extremely few of the buildings in the United States which are wired are inspected before being closed in by lath and plaster; and

Whereas, an inspection after such closing in is incompetent and worthless, for the reason no means are known to the electrical profession by which the fire hazard of concealed or inaccessible circuits may be determined, and that a visual examination of all circuits must be had before immunity from fire hazard can be assured; and

Whereas, by the reason of non-inspection, the work of incompetent and irresponsible electricians remains for ever permanently concealed and uninspected, thereby affording ample opportunity for evading the requirements for safety, for practising gross impositions upon fire underwriters and the public, and imperilling millions in property valuations; and

Whereas, only through the use of insulating wireways is it possible to render concealed wiring permanently accessible; and

Whereas, such permanent accessibility renders it possible to thoroughly inspect at any time every installation so wired, and ensures trustworthy means for the detection of every piece of defective wiring of whatever nature: therefore, be it

Resolved, that the use of such insulating wireways for rendering concealed wiring permanently accessible be, and hereby is, most heartily endorsed and recommended; and be it further

Resolved, that such methods of accessible concealed construction be, and hereby are, advised for general use.

Resolved, that the secretary be requested to communicate with the American Institute of Architects, asking co-operation of their Association in an endeavour to have architects, when drawing plans for specifications, make provisions for the channelling and pocketing of buildings for electric light or power wires.

Resolved, that they also be requested in specifications for electric gas lighting to require a two-wire circuit, whether the building is to be wired for electric lighting, or not, and that no part of the gas fixtures or gas piping be allowed to be used for the gas lighting circuit.

Physical Society.

SPECIAL MEETING, NOVEMBER 22nd, 1895.

CAPTAIN W. DE W. ABNEY, President, in the chair.

The following resolution, with reference to the Articles of Association, was passed:—

In Article 33, to strike out the words "by the payment of £10 in one sum," and in place of this to insert the words "the composition fee shall be, for every member who shall not have paid ten annual subscriptions, fifteen times the amount of the annual subscription payable by such member, and for any member who shall have already paid ten or more annual subscriptions, ten times the amount of the annual subscription payable by such member."

The ORDINARY MEETING then took place.

Dr. G. JOHNSTONE STONEY exhibited a print of Profs. Runge and Paschen's photograph of the spectrum of the gas obtained from clevite, together with a diagram illustrating the manner in which these observers have arranged *all* the lines obtained in two sets, each set containing three series of lines. Dr. Stoney also drew attention to the resemblance between each of these sets of three series of lines

and the similar triple series obtained in the case of the metals of Mendelejeff first group. The lines of the different series in the case of the gas obtained from clevite have certain definite peculiarities which permit of their identification and selection. The two gases, to the presence of which the two sets of lines are presumably due, can be partly separated by diffusion through a plug of asbestos. Prof. Ramsay's observation, that by suitably altering the pressure of the gas the predominance of the lines in either of the two sets can be increased, is, however, against the theory that the two gases are really separated by diffusion. Three of the original negatives taken by Prof. Rowland, when preparing his map of the solar spectrum, were also exhibited.

Dr. Gladstone said he had examined the spectrum of the gas in two tubes, one of which had been filled by diffusion through an asbestos plug, and the helium line (D_3) was certainly brighter in one tube than in the other, though the brightness of the remaining lines appeared about the same in both tubes. As to the difficulty of allocating the new gases in Mendelejeff's table, it appeared to him (Dr. Gladstone) that they would have to be put in the first group, between hydrogen and lithium. An examination of the successive differences between adjacent members of the metals in the first group showed that these differences increased as we go downwards. If, then, the new gases have atomic weights of, say 2 and 4, we should have for these differences 2, 2, 3, 16, 16, 26, &c., instead of 6, 16, 16, &c., as at present. The important point which required investigation was whether these two gases were really simple bodies or not.

Prof. Silvanus Thompson asked if Runge and Paschen had performed a similar analysis of the lines in the spectra of other elements besides the members of the first group. He would also like to know if in the use of any element besides hydrogen the lines could be arranged in a single series.

Dr. Stoney, in reply, said that the spectra of most of the metals had been analysed, the chief exceptions being iron, nickel, cobalt, and manganese. There was no other element besides hydrogen which gave a single series of lines.

Prof. Herschel gave an account of a line of reasoning which had led him many years ago to a formula resembling that expressing Balmer's law for the hydrogen lines, namely, $\frac{1}{\lambda} = 1 - \frac{4}{n^2}$.

The Chairman (Captain Abney) drew attention to the fact that Runge expressed his results to $\frac{1}{1000}$th of an Angström unit, although Dr. Stoney said the measurements could only be made to within $\frac{1}{50}$th of a unit. There was great lack of uniformity in the method of drawing spectra in general use; he strongly recommended the placing of the red end of the spectrum to the right, so that the wave lengths increased from left to right. As to the three series of lines obtained in the case of most elements it was not conclusively proved that they were not due in each case to three distinct kinds of molecules, and it will probably be found that there are more than two simple gases present in the gas evolved from clevite.

Mr. R. Appleyard read a note on the "Action of Sulphur Vapour on Copper."

When a copper wire is exposed for some time to the action of sulphur vapour it becomes entirely converted into sulphide of copper, and it is found that there is a fine axial hole running down the rod of sulphide formed. Rods of copper of square section cut from a block of copper, after exposure to the action of sulphur vapour, also exhibited the axial hole, the rod of sulphide formed being of circular cross-section. In every case the diameter of the rod of sulphide formed is about twice that of the original rod of copper. Delta metal was found to be unacted upon by the sulphur vapour.

Mr. Appleyard then read a paper on a "'Direct-reading' Platinum Thermometer."

This form of platinum thermometer has been devised with the view of determining the temperature of the dielectrics employed in some experiments on the variation of the electrical resistance of dielectrics with temperature. The thermometers consist of six platinum coils, each of about 7 ohms resistance, attached to thick copper leads. A slide-wire Wheatstone's bridge is employed to measure the resistance. The stretched wire is 3 metres long, and the moving contact so arranged that it is impossible to damage the wire. The auxiliary coils used in connection with the bridge are immersed in a bath of paraffin oil, the temperature of which is maintained constant, and a little above that of the air, by means of a glow lamp immersed in the oil.

Mr. Appleyard also read a historical note on "Resistance and its Change with Temperature," in which he showed that the earliest measurements of the variation of resistance with temperature were made by Lenz in 1833. Some experiments on this subject made by Davy are also referred to, and some of these experiments were repeated before the society.

Mr. Trotter said he agreed with the author that the "reserve of precision" at our disposal on account of the delicacy of some of the modern instruments ought to be made use of to facilitate the rapid performance of many measurements where the utmost accuracy is not necessary. He had the impression that platinum-silver was not now considered the best material for use as the bridge wire.

Mr. H. F. Burstall explained the differences between the temperature as measured on the mercury, air, and platinum thermometers. At a temperature of about 40 degrees the platinum thermometer read about 0°·4, and the mercury thermometer about 0°·1 below the air thermometer. Prof. Callendar had obtained measurements of temperature correct to within 0°·1 by using a Weston voltmeter and an ordinary Wheatstone bridge, the variations of resistance, and hence the temperature being read directly from the deflections on the voltmeter.

Mr. Rhodes thought that except where extreme accuracy was necessary, the mercury thermometer was very much more convenient than the platinum thermometer.

Mr. Burstall said the great convenience of the platinum thermometer lay in the fact that the scale could be read at a distance of many yards from the point where the temperature was being measured, and hence it could be used in many places where it would be impossible to read a mercury thermometer.

Mr. Blakesley considered that the author was somewhat bold to state that it was for general purposes never necessary to measure temperature to nearer than one-tenth of a degree.

The author having replied the Society adjourned till December 13th.

THE FIRE AT CHELMSFORD.

The accounts which have appeared in the Press regarding the disastrous fire which occurred at Messrs. Crompton's works, and the Chelmsford Electric Lighting Company's station at Chelmsford, last Friday morning, would appear to be much exaggerated. From information furnished on the spot by Mr. Crompton, we understand that, at present, the damage and loss are estimated at from £50,000 to £60,000, the insurance of the destroyed and injured buildings and plant, &c., amounting to about £48,000.

It is, however, impossible to ascertain at present the exact extent of the loss incurred. For instance, there is among the *débris* a planing machine which cost about £1,000, and it cannot yet be stated whether it is still worth several hundreds of pounds or nothing at all. Among the lost is £20,000 or £25,000 worth of machinery, fittings, &c., and partly made apparatus, which was in progress when the fire occurred.

What will prove to be one of the most severe losses is said to be the total destruction of all the gauges and templates, and nearly the whole stock of the drawings which had been preserved for many years by both companies. Every utensil used in the drawing office was lost, and a number of fresh sets were ordered immediately. In most cases these belonged to the employés, and a similar loss has to be borne by some of the other hands whose tools were destroyed. One interesting point is, that the only department devoted to heavy tool work saved was the original shop, which Mr. Crompton had built in 1879, in which the plant then laid down remains intact. The first large lathe Mr. Crompton ever possessed is in this department. It is the company's intention, we understand, to start as soon as possible a few tools, put all the lathe machining out, and do only the light machining themselves. In temporary sheds which have been erected, half the armature work can be carried on. The arc lamp shops, finished part dynamo stores, boilers, smithy, and the outlying shops are practically uninjured, and in these operations are proceeding very rapidly, as many men being set to work as the shops will possibly accommodate. Immediate steps are being taken to resume the manufacture of dynamos. To overcome any difficulty which might arise in turning out the larger work, electrical firms have been very willing to render assistance to Messrs. Crompton, they having been approached to this end by Messrs. Siemens Brothers, Messrs. Scott & Mountain, Messrs. Mather & Platt, the Brush Company, Electric Construction Company, and Messrs. Marshall, Sons & Co., who were anxious to help them over their troubles. There is at present on order a very large machine, which is stated to be equally as large as that just laid down at Deptford by Messrs. Ferranti; this will be completed at Messrs. Marshall's.

The plant used for generating supply for the town public and private lighting was destroyed, and this is, of course, a very serious matter for the town; but temporary arrangements were immediately proceeded with for the resumption of the street lighting, and by Tuesday evening it was hoped to have all the arc lamps, covering about one mile of streets, lighted, and most of the incandescent, covering about 13 miles

of streets, on again. Temporary sheds have been rigged up in some parts, traction engines procured in the town being made use of for driving the small generating plant. But for these improvised central stations, the difficulty of lighting the town would be exceedingly great.

The private lighting will not be resumed for a week or ten days. At the present moment Messrs. Crompton cannot get enough power to light even their own workshops, after the street lamps are supplied.

On Monday, between 200 and 300 of the usual 600 hands were at work, and others will be taken on as opportunity occurs. One of the improvised stations where a traction engine has been put down is in the yard adjoining the lamp shop, and this, supplied with steam from the boilers in the works, which were uninjured, is now driving the machinery in the lamp department, and also working the present lighting arrangements at the works. The newly erected sheds, which were happily uninjured, and which were to have been used as manufactories for heating and cooking appliances, will as soon as possible be utilised for armature winding and so forth.

The following circular has been issued by the company, and accompanies a notice of the fire which is being sent out:—

Arc Works, Chelmsford,

November 25th, 1895.

Dear Sirs,—With reference to the enclosed circular, will you kindly let us have copy of any order of ours that you have unexecuted, statement of account, and any invoices that you have not rendered.

Should you have in your possession any sketches of ours in connection with any orders given you by us, please to let us have them.

So far as can be ascertained, we are fully covered by insurance, although no doubt we shall sustain loss through the inconvenience and partial stoppage of our business for a little while. Still we are hoping, when we are able to start full work again, our friends and customers will give us the support they have hitherto done.

All catalogues that we had have, unfortunately, been destroyed in the fire. Will you please provide us by return with a new set of any that you issue, also giving your rates of discounts, &c.

Yours faithfully,

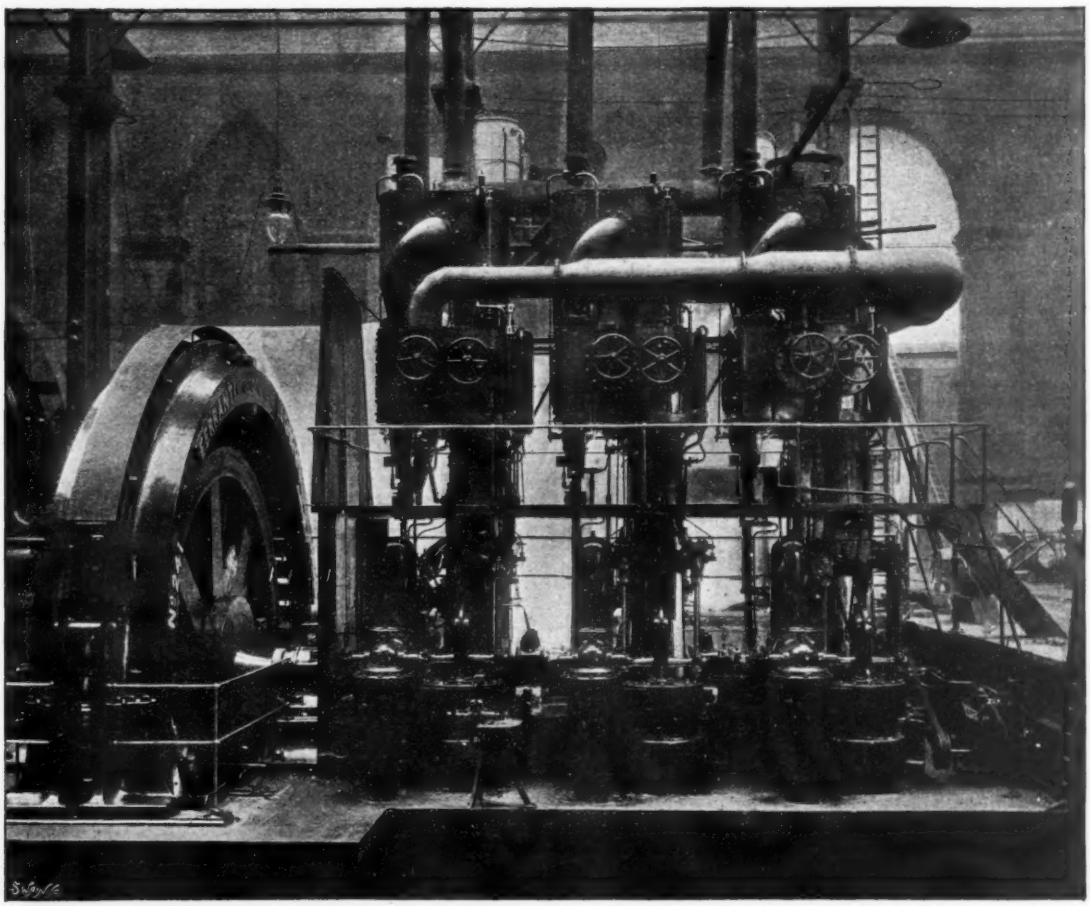
Crompton & Co., Limited.

Electrical men are doubtless anxious to know the exact cause of the conflagration. There is, unfortunately, no direct evidence as to what started the fire, and this will probably remain a mystery, although a searching enquiry ought to elicit enough to render the probable cause to be forthcoming. It is assumed that it originated in the store room, or thereabouts, and according to the statements made by Mr. Crompton, the switchboard, or other electrical fittings or leads, were in no way responsible, although rumours were current, and have been published in the daily Press, that fusion of wires was the cause. We understand that there was a resistance fixed near the roof, but it was thrown out of circuit and never used, the engineer-in-charge having disapproved of it. Mr. Crompton had passed the switchboard—which was nearly new—the night before as an exceedingly good piece of work.

The men went to breakfast at 8.15 on Friday morning, and at 8.40, just before their return, smoke and fire were observed by the man in charge, who immediately took out his plug switches. It appears, however, that others had previously noticed volumes of smoke issuing from the windows of the store-rooms and general offices above the lighting station; in fact, the fire seems to have taken a complete hold of the buildings before it was possible for attempts to be made to suppress it.

There was a very light load on at the time, only one machine running.

Central station fires are becoming far too frequent, and the destruction of Sardinia Street, Kensington Court, Chelmsford, and other supply buildings, will have their effects in



Deptford.—View of New Unit.

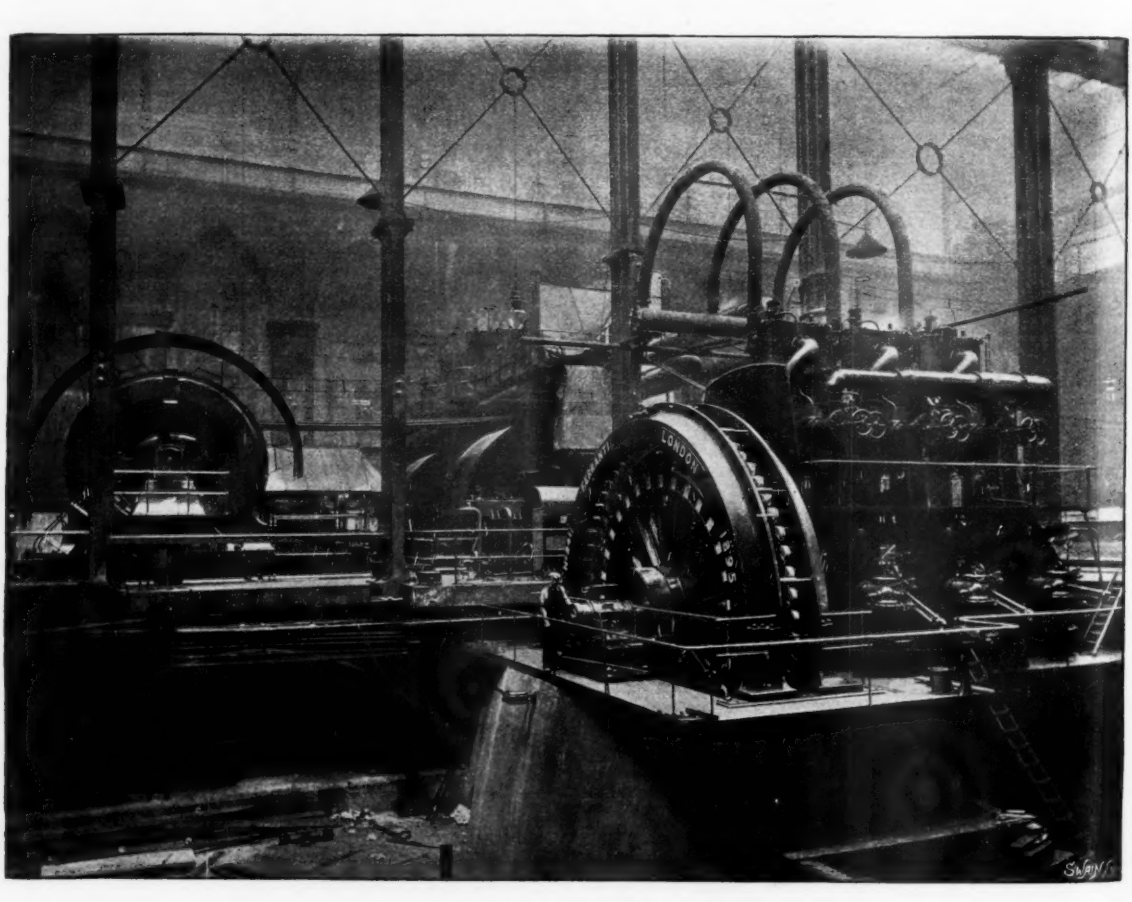
more ways than one. There is little doubt that unless electric lighting stations are made fireproof, and all inflammable material kept at a reasonable distance, they stand as much chance of catching fire as any other buildings. Special means must therefore be taken to make them fireproof, as we have already recommended on several occasions.

This second misfortune to Mr. Crompton is much to be regretted, and we are pleased to note the very hearty manner in which rival firms hastened to his assistance.

DEPTFORD REVISITED.

It is something like five years since we last visited and described the Deptford works of the London Electric Supply Corporation. Since that date the company has passed through many vicissitudes, and has experienced some sore trials. It can, however, claim to have fully demonstrated one of the principles on which it commenced operations, that is, the transmission of electric energy at 10,000 volts. Indeed, the ideas of Herr Rathenau, in the interesting article on the "History of a Great Electrical Company" in our last issue, are following very closely on the original lines set forth by the London Electric. Financial troubles, arising to a great extent out of an unfortunate series of accidents, prevented for some time the development, or, we should say, the re-development of the lighting business, but there is now every reason to believe that the company is in an exceedingly sound position, and the addition of the new plant, which we shall describe, will materially help the capabilities of the company. The illustrations, which we are able to reproduce through the courtesy of Mr. D'Alton, the engineer-in-chief of the London Electric Supply Company, include a view of what are now fairly old Ferranti machines, driven by vertical engines by Plenty & Sons. There is also an interesting view of a bank of transformers, which are raising the current from the 2,000-volt machines to 10,000 volts for transmission to London; the switching gear on these transformers is very similar to that employed at the sub-stations. Its principle is that of contacts which slide along a rack, the operation being controlled by a long wooden handle. There are some features of interest in the new switching gear, which we hope to speak of in a subsequent issue.

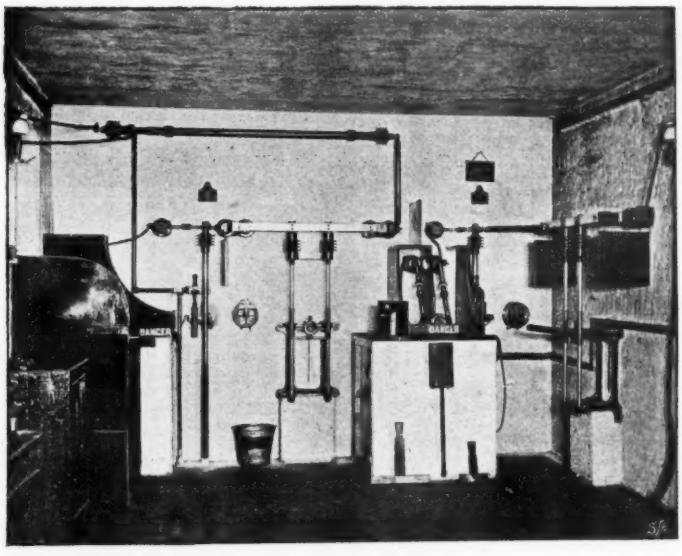
The most striking feature of the works is the recently completed 1,000 unit machine. To our way of thinking, it is an admirable piece of work, its apparent strength and finish being specially noteworthy. It is an interesting fact also that this machine is the largest in Europe at the present moment. The machine is coupled direct to a vertical compound engine by Messrs. Plenty, of Newbury, which has three cranks at 120° each, driven by a compound tandem engine; this combination naturally ensures a very even turning movement. The dimensions of the cylinders are 16 and 27 inches, with a stroke of 26 inches. The



Deptford.—View of New Unit.

engine or engines run at a speed of 156 revolutions, and indicate 140 lbs. in the high pressure cylinder. Worked with a boiler pressure of 175 lbs., each engine will develop 500 H.P., but when working at a pressure of 200 lbs. they are capable of delivering 2,000 H.P. The low pressure cylinders are so arranged that they can exhaust direct to the atmosphere, or to the condenser, the condensor ejector being placed at the back of the engines. The shaft is of Siemens-Martin steel, and is 10½ inches in diameter, the bearings on the crank shaft being 15 inches long. The shaft is made in three interchangeable lengths in case of breakage, so that the engine would run little chance of being disabled. Although the three engines are intended to be run under ordinary circumstances as one, it is quite easy to run one, two, or in any other way desirable. The controlling is done by means of Joy's patent gearing and worked by means of water pressure, which is pumped in through the centre of the crank shaft to a

plunger on one side of the eccentric, thus pushing the eccentric over into full gear; if the speed of the engine exceeds the revolutions for which the ball governor is set, the balls will fall, and thus relieve the water pressure from the eccentrics; a powerful spring will then push the eccentric over into gear or towards mid-gear to relieve the engines. It will be seen from our illustrations that each engine has its own separate steam and exhaust pipes. The steam pipe is 15 inches in diameter, and is large enough to carry steam for another unit similar to the one we are now describing. The telescopic system of lubrication is employed throughout the engines. A rather important point is the absence of stuffing boxes between the high and low pressure cylinders, the piston rod is carried through a long sleeve, and there is no leakage at all between the two.



Trafalgar Sub Station.—Point of Entry of 10,000 Volt Mains.

The block of concrete, on which the engines and alternators stand, is rather interesting; it weighs upwards of 360 tons, and was put down specially for this machine. Through the middle of the block, direct under the engines, a tunnel has been driven; this enables one to watch the armature turning at its lowest point; it also provides an easy way down into the race of the dynamo.

The alternator is designed to give 100 amps. at 10,000 volts working pressure, and to be capable of giving 11,000 volts, at 156 revolutions, 83 cycles, and works in parallel with the existing units, which are as follows:—two 1,000-unit machines, rope driven by vertical compound engines, by Hick Hargreaves and Co.; speed 75 revs., one machine giving 10,000, and the other 2,500 volts. Two 475-unit machines, rope driven by horizontal single crank tandem compound, by Hick Hargreaves & Co.; speed 60 revs., both machines giving 2,500 volts. Two 225-unit machines, rope driven, vertical triple, expansion engines, by Messrs. Plenty, of Newbury.

New Machine, Running.

No flexible coupling is used, the engine and dynamo shafts being rigidly connected by nine 2-inch diameter bolts.

The dynamo shaft, which carries the fly-wheel and armature, is supported by two spherical bearings, 12 inches diameter × 36 inches long, the bearings being of cast-iron, lined with white metal; the lubrication is forced by means of a separate pump for each bearing, this method of lubrication having been found both effective and economical from previous experience, when dealing with heavy bearings. All end thrust is also taken up in these bearings, the design of armature rendering this of the first importance.

An interesting feature is that the standards carrying the bearing act as storage chambers for the lubricant, that on the engine side being coupled direct on to the engine bedplate.

The armature wheel, or fly-wheel, is 26 tons in weight, of which 14 tons are in the rim. It is secured in position by shrinking two hoops over the boss of the wheel, which is bored a dead fit to the shaft. The wheel proper consists of two castings, each having four arms of H-section, each arm being independent of the boss. When mounted in position, the joint of the rim is secured by shrinking on two mild steel hoops of massive section, over machined projections from inside the wheel. The wheel is further strengthened by eight tie bolts of 6 inches diameter minimum section, which are screwed into a mild steel casting shrunk on to the centre of the shaft. These bolts are heated after being screwed up, and being again screwed down, are given a definite tension. This wheel has been designed, firstly, to have a large factor of safety while supporting an armature which, by its own weight, increases the centrifugal force by nearly 30 per cent., and, secondly, to run perfectly true.

The armature is insulated and supported in the manner usually adopted by Mr. Ferranti. Cast steel nuts are held in cored recesses, in the fly-wheel rim, by means of sulphur compounds, and from these insulated steel bolts project through rim to support the armature. These bolts are insulated by ebonite cured on before machining is completed, and each bolt can thus be tested before being used in construction; 64 pairs of these bolts support the armature, the 128 coils of which are held in pairs between bronze holders; the coils of bare corrugated copper strip are wound on cores of corrugated brass strip, separated by asbestos, burnt together into a gun-metal block. Each pair of coils is mounted in its holder, into which it is riveted under an hydraulic press, the result being a very mechanical armature, having no loose wires or connections.

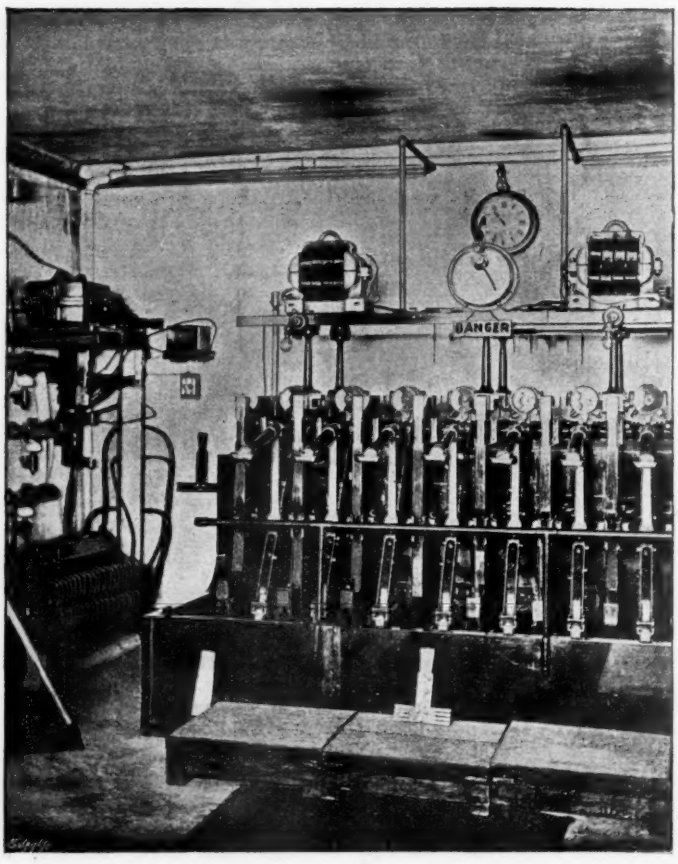
The insulation of the coils, owing to the above construc-

tion, is a comparatively simple matter. Each pair of coils, generating 620 volts, is insulated to withstand this pressure with ample margin, the whole armature being mounted on insulated spokes, which have to withstand the full pressure of 10,000 volts. The overall diameter of armature is 22 feet, thus the peripheral speed is 11,000.

The field magnet frame consists of eight castings, in which are mounted 128 field magnets, 64 on each side of armature, and have a total weight with field poles and copper of 37 tons. The field coils are wound with bare copper on edge, this system securing the maximum copper in a given space with the best radiation.

The pole faces are protected by means of caps under the patent principle adopted by Mr. Ferranti with his former machines, and are made of micanite manufactured by Messrs. Bergtheil and Young.

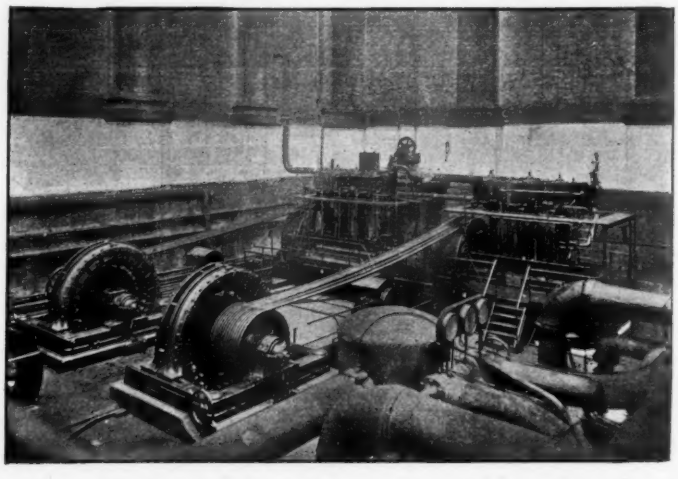
For cleaning and other purposes, a 1-unit motor is provided, which separates the two field magnet frames driving separating screws by means of gear wheels, five minutes being taken to open or close the machine.



Trafalgar Sub-Station.—Feeder Switches.

The following are the leading particulars:—Height of machine from floor line, 14 feet 6 inches; overall length, 24 feet; width from outside pedestal to engine coupling, 12 feet 6 inches; copper loss in armature, ·85 per cent.; copper loss in field magnets, 1 per cent. The total weight of alternator, with beds, shafts, and fly-wheel, is 80 tons.

Before being used for commercial purposes, the armatures of the machine was tested, standing with the field magnet frames at working distance, with 21,000 volts at 83 alternations, corresponding to 30,000 volts direct current, and afterwards, when running, generated on three occasions over 12,000 volts, without failure of insulations. A point of some interest is the painting the side of the fly-wheel rim in alternate squares of black and white. It will be remembered that at Portsmouth, when one of the Ferranti machines was not in synchronism, the fly-wheel, when looking at the coils, had the appearance of moving backwards. This effect has been utilised at Deptford for synchronising purposes. When the machine is not moving fast enough, the fly-wheel has the appearance of moving backwards, while if moving too fast, it apparently goes forward. This forms a rough indication to the man at the switchboard what the machine is doing.



View of Ferranti Alternators Driven by Plenty Engines.

There have been slight changes in the method of working at Deptford since we were last there. The most noticeable is the change in position of the switching gear, which is being slowly transferred to a gallery running alongside the wall. The gear is not yet complete, but, as we have already mentioned, we hope to speak of this more in detail at a subsequent period. The main switches under this arrangement will be worked by a system of levers, which, so far as we could see, is a safe and simple one.

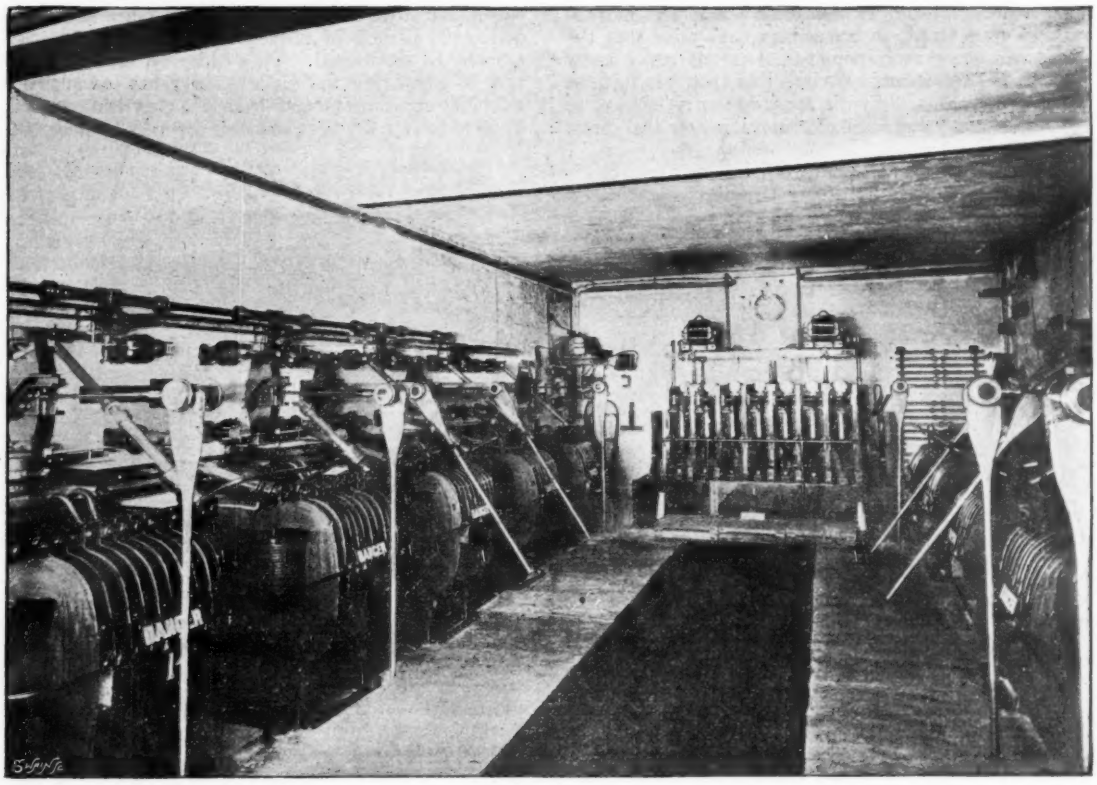
We mentioned some time ago that the feed water for the boilers was obtained from a well which has been specially sunk. This has resulted in a marked economy. Water for condensing purposes is obtained from the river, but the water at neap tides is so low that a supply becomes difficult to obtain. Mr. D'Alton has overcome the difficulty by sinking a well, 6 feet diameter and 25 feet deep, close to the river's edge, inside the river line, a plentiful supply of water being always at hand. The water for condensing purposes is not taken direct from the river to the condensers, but to a tank which holds about 6,000 gallons of water.

It will be seen that there are some interesting illustrations of one of the sub-stations. At the present moment the 10,000-volt current is transformed and distributed at 2,000 volts by means of four sub-stations, the Trafalgar, the Black-

friars, Belgravia, and the Grosvenor Gallery. The position of these is sufficient to show the extraordinarily wide ramifications of the system. In the Trafalgar station the extra high tension mains enter the building at one end and pass round the room, the transformers being thrown in and out of this circuit by means of the long handle switches, to which we have already referred. The current then passes to the 2,000-volt switching gear, which controls seven feeders. The sub-stations are connected together so that one helps the load of the other.

The evening load on the Deptford station is about 600 ampères at 2,600 volts; the load curve is a kind of intensified church steeple, the increase being often as much as 250 ampères in 20 minutes. The average daily output in Board of Trade units is about 11,000, though a foggy day may mean an increase of 50 per cent.

The new plant, which has now received extended trials on the feeding circuits, will begin regular work in a few days.



Trafalgar Sub station.—Transformers and Switching Gear.

INCANDESCENT LAMP EFFICIENCIES.

In our last issue Mr. John W. Edmundson, the managing director of the Sunbeam Lamp Company, Limited, protested against the conclusions we arrived at in discussing some tests of incandescent lamps that we summarised in our number of the 1st inst. The objections urged against these tests, which were characterised as being "without authority" and as unfair, were that there is no information given regarding where the experiments were carried out or by whom they were conducted. We were aware that the figures are due to Mr. D. Paisley, whose name we have come across at various times as a contributor to the technical Press, and the responsibility for their correctness must rest with that gentleman; but the description of how they were obtained was so straightforward and the skill required for work of a practical kind is so small, that we see no reason for disputing the data beyond the fact that some of the results do not quite fall in with our preconceived ideas.

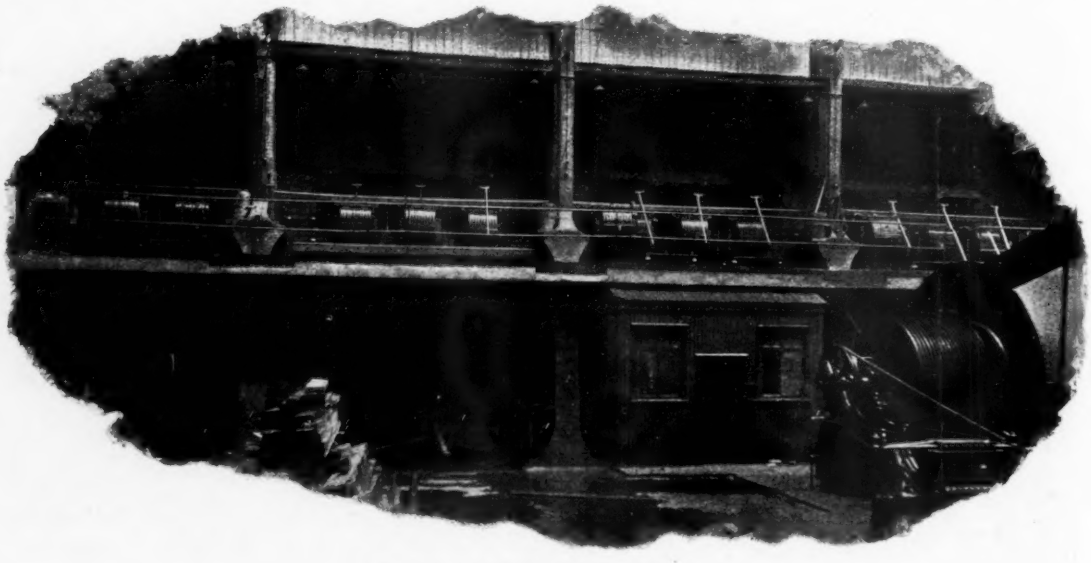
Our article was, however, based on more than this. The writer had at various times made tests of incandescent lamps on his own account, and the general results were in accordance with the tenor of what Mr. Paisley gave as his. At the same time we must admit that the method of testing is not fully described, and we are not told where the lamps were tried, or the source from which the current used in the test was taken. It is only fair to asssume that the measurements were made with commercial instruments of a recognised type, and such instruments do not require any great skill in their use; otherwise it would be necessary to ask for some guarantee that technical skill and ability of a fairly high order was employed, and that the apparatus used was of a suitable kind. But it is expressly stated that the apparatus was checked against standard instruments at frequent intervals, and unless the good faith of the investigator is called into question, one cannot very well criticise direct statements of this kind. One may be permitted to give figures obtained in this way, and offered as being of a practical kind, where others submitted as representing with rigorous exactness certain facts, would require a very much more reliable substantiation than has been given so far.

It is at the same time most desirable that tests should in all cases "be made by persons whose names are known, and whose position is a guarantee at once for absolute independence and high scientific attainment." We can judge of these qualifications to some extent by the means taken to publish experimental results. Well known scientific men usually chose the *Journal* of a learned society, others the columns of the technical Press. The authentication of results largely depends on the fulness with which information is given as to the means adopted to obtain data, and the corrective factors introduced. One thing about which we know nothing is the kind of current or circuit on which these batches of lamps were tested. Mr. Edmundson might well question results that were obtained on a circuit with current taken from public supply mains. Nothing has been said as to whether the potential difference across the lamp terminals was maintained constant by automatic or other means, and if so, how nearly a desirable uniformity was reached.

Without going so far as to say that these results are "valueless for practical purposes," we cannot hide the fact from ourselves that Mr. Paisley seems to have tried to strike a good bargain by giving his figures to papers that are not regarded as technical to the electrical engineering world, and he seems to have sought simultaneous publication in an American and an English journal. The use that has been made of the figures, by one firm especially, who appear to have been favoured with permission to reprint the tests, might lead a thoughtful individual to rather disquieting conclusions; but apart from this, we will take up an article that has appeared in the English journal which gave prominence to Mr. Paisley's results.

It is suggested that the test was a good one, because taken under "ordinary working conditions." This defines nothing; we might well ask "under what ordinary working conditions?" The method of running the lamps, and of taking the electrical and photometric measurements, are things that need to be specified, as they do not form a part of the ordinary working conditions of an ordinary private plant or central station. When, however, we meet with a statement like the following, a grave suspicion comes into one's mind that the man who can write such nonsense, does not really know what he is talking about. We are told that, "in fact the energy or watts consumed by the lamp during its life had to be included in any estimate of the value of the lamp. Before we can properly estimate the value of an incandescent lamp, we must know four things:—1. The primary cost. 2. The cost to the consumer of a watt. 3. The candle-power of the lamp for the time under consideration. 4. The length of life of the lamp in hours." "Writing this in mathematical terms we have:—Price per C.P. per hour = primary cost of lamp × cost of watt × number of watts per C.P./life of lamp in hours." This is entirely fallacious as an argument, and nonsense so far as the terms go. The writer evidently thinks that the watt is a unit of energy! Perhaps he is unaware that it refers to power and not to work. He also talks about "mathematical terms" where the simplest arithmetical expression is used. But he blunders still worse in assessing the life of a lamp that has lasted 600 hours, at 600 hours. The proper way of estimating the cost per C.P. hour would be (cost of lamp + {price per Board of Trade unit × number of units consumed during the life of the lamp})/life of lamp in hours × mean candle-power. The last quantity would have to be derived by a process of differentiation from the curve co-ordinating life with candle-power. If lamp tests are to be of any use at all, they must be free from gross blunders.

A contemporary devoted to gas interests makes merry over the fact that an 8 C.P. lamp is conventionally taken to represent a demand of 35 watts. Surely our gas friend is aware that an average figure of this kind is only used in such cases as the estimation of the number of lamps connected to a central station circuit, and it is usual to adopt a convenient unit in all such cases? A unit, to be suitable, should be smaller than the average single quantity measured, and in this way an 8 C.P. lamp, being the smallest in general use, is handy. As nine out of every ten lamps installed are of higher candle-power, 35 watts per *equivalent* 8 C.P. lamp is very nearly right; 16 C.P. lamps take 60 watts, and 8 C.P. 38 watts, so that the 8 C.P. equivalent of one 16 and one 8 C.P. lamps would be less than 35 watts by a considerable margin. We therefore do not see that "here, again, the electricians have been kind to themselves."



Deptford.—Bank of Transformers.

RESEARCHES ON DISSOCIATION.

A valuable contribution has been made to our knowledge of that much debated subject, "dissociation," by A. A. Noyes and C. G. Abbot, which will do much towards elucidating the methods of research by means of which it should properly be approached. They addressed themselves to the task of comparing the dissociation values calculated from solubility experiments and from the electrical conductivity, by no means an easy task, and their paper in *Technology Quarterly* will be received with enthusiasm by all those who are working in that obscure field of research which has been made famous, polemically speaking, by Svante Arrhenius.

The application of the law of chemical mass-action to the case of saturated solutions of partly dissociated salt leads to the following principle, which was first expressed by Nernst: "The product of the masses of the ions of the salts with which the solution is saturated remains constant in the presence of other salts." The exactness of this principle is, however, not as yet thoroughly established. It is, indeed, doubtful whether the law of mass action may properly be applied to this case, since the dissociation of salts as derived from electrical conductivity measurements does not vary with the concentration of the solution in accordance with the requirements of that law. Moreover, experimental investigation of the Nernst principle has not led to decisive results.

The first experiments relative to the Nernst principle were conducted by Nernst and Noyes (*Zeits. für Physik. Chem.*, iv., 372, and vi., 241). The solubility of a salt which is soluble with difficulty, was determined both in pure water and in the presence of other soluble salts which had an ion in common with the first. The solubility of such a salt in the presence of the added salt was also calculated, with the help of the Nernst principle, from the values of the dissociation obtained by means of electrical conduc-

tivity measurements. The agreement between the observed and calculated solubility values was only approximate. It was, however, uncertain whether the cause of this deviation lay in the failure of the Nernst principle, or in the inaccuracy of the dissociation values calculated, under the assumption that the electrical conductivity of salts is exactly proportional to their dissociation.

Later, Arrhenius (*Zeits. für Physik. Chem.*, xi., 391) made similar solubility measurements, and calculated the dissociation of the salt, which is soluble with difficulty by means of the Nernst principle, without the help of electrical conductivity experiments. Obtaining disagreeing values from different series of experiments, he concluded that the solubility principle is incorrect. But his calculations involved the assumption that the dissociation of the saturating salt is the same as that of the added salt, which assumption is certainly groundless, so that his experiments do nothing to settle the question of the validity of the solubility principle.

Recently the results of Godwin (*Zeits. für Physik. Chem.*, xiii., 613) have lent indirect support to the principle, for he shows that other methods (namely, the electromotive force and the conductivity method) lead to the same values of dissociation as the application of the Nernst principle itself.

Now on account of the great importance of the Nernst principle, a direct analytical proof of its accuracy is very desirable. This has been fortunately realised by Noyes and Abbot. It was the aim of their experiments to make such a test by a method which requires no other data than the following :—(*a*) Experimentally derived solubility values; (*b*) The principles of solubility, which may be stated to be: 1. In a saturated solution of a salt, the absolute amount of the undissociated part remains constant, even in the presence of other salt. 2. The product of the masses of the ions of the salt also remains constant.

So long as the effect of a soluble salt on the solubility of one which is soluble with difficulty is investigated, some further assumption is necessary for the calculation of the dissociation of the latter. If, however, two salts are taken which are both in a saturated solution, and the effect of each in diminishing the solubility of the other is measured, then the two foregoing principles permit of the calculation of the dissociation of each. By investigating three salts in pairs, two independent check-results may be obtained on the dissociation of each salt, and the validity of the solubility principles may be judged of by the closeness of their agreement to suit the required conditions. The chloride, sulpho-cyanate and bromide of thallium were selected. These were combined in three pairs, and for each pair the solubility of each salt was determined in a solution in which both salts were present in excess.

Much attention was devoted to the preparation and analysis of the salts, and the methods of procedure were very carefully thought out and observed. These are described at great length and detail in *Technology Quarterly*, and it seems almost impossible to condense them. The experimental results are then set forth in tables, and then follow other tables in which are summarised the final solubility values and the corresponding diminution of solubility. The equations, whence the dissociation values are obtained, are then discussed, and the following results are deduced as *the most probable* values for the dissociation :—

Thallium chloride	86·5 ± 0·3
„ sulpho-cyanate	86·6 ± 0·3
„ bromate	90·2 ± 0·4

Perhaps of much greater interest than the dissociation values themselves is the agreement of the results of the independent experiments of each pair of salts. The agreement is, by chance, exact for the first two pairs, and for the last pair it falls within the limits of experimental error. The conclusion is, therefore, justified that the solubility principles are exact. But Noyes and Abbot go further: they examine the grounds for this conclusion, and then give a neat little proof of the validity.

This naturally closed the investigation, the original purpose of it having been accomplished. Then arose, however, a question of perhaps even greater importance, namely, the question of the trustworthiness of the dissociation values obtained by the electrical conductivity method. The possibility of checking the values of dissociation by means of wholly independent experiments is a peculiarity of the solubility method; for each of the physical methods, such as conductivity, freezing point, gives only a single dissociation value, whose correctness can only be estimated by the agreement of its results with those of other methods. Therefore Noyes and Abbot measured the conductivities of the three thallium salts and calculated their dissociation.

The conductivity measurements were carried out according to the method of Kohlrausch, in a resistance cell of the form devised by Arrhenius, and tables containing the values resulting from these measurements are given.

It remains only to notice the comparison of the dissociation values obtained by means of the solubility measurements with those obtained by the conductivity method.

Salt.	Dissociation from solubility effect.	Dissociation from electrical conductivity.
Thallium chloride ...	86·5 ± 0·3 ...	86·6 ± 0·1
„ sulpho-cyanate	86·6 ± 0·3 ...	85·6 ± 0·1
„ bromate ...	90·2 ± 0·4 ...	89·0 ± 0·1

The agreement between the values is for the salt complete, and the difference in the case of the two latter is within the possible error of experiment.

It is therefore proved by these experiments that the solubility and conductivity methods for the determination of dissociation lead to the same results.

The results of this investigation may be summed up as follows:—With three salts of very different nature, and of different solubility and dissociation, it has been proved first, that two principles of solubility effect are valid, and second, that the values of dissociation obtained through the electrical conductivity agree with those calculated from solubility measurements. Owing to the confirmation of the correctness of the values of dissociation obtained by the conductivity method, it is shown conclusively that the law of mass-action cannot be applied to determine the change of dissociation with the dilution. The law, as applied to the dissociation of salts, must therefore be modified as follows: *The product of the concentrations of the ions at different concentrations of the solution is* not *in a constant ratio to the concentration of the undissociated salt; but corresponding to any given concentration of undissociated salt, the product of the concentrations of the ions has a constant value, which is altogether independent of the relative concentrations of the separate ions.*

It is obviously desirable that there should be further solubility experiments of a similar nature, in order to decide the question up to what concentration the solubility principles and the dissociation values obtained by the conductivity method are trustworthy. Such an investigation is rendered much less arduous, owing to the work now recorded, and the thanks of all who are interested in this field of research are due to Messrs. Noyes and Abbot.

CORRESPONDENCE.

Electrical Tanning.

It may, perhaps, interest some of your readers to know that M. Worms has patented a new accelerated process of tanning, different from that of M. Worms & B's., and which is in practical use by the "Société der Tannage Français," in Paris, where it seems to be giving such excellent results that the Society have decided to considerably increase their plant. Should any of your readers care to investigate the matter, I shall be most happy to give a letter of introduction to M. Worms to any one you may please to recommend. M. Worms will enable him to follow every phase of the process. He may, if he likes, choose the skins to be tanned, have them put in the revolving drum in his presence, seal up the drum, time the operation, and have the skins taken out and examined in his presence. In short, M. Worms will be very pleased to afford him every opportunity to thoroughly study the process, without risking more than the expenses of a journey to Paris, and I can guarantee him a friendly reception.

G. A. Nussbaum.

London, *November 22nd*, 1895.

The Institution of Electrical Engineers.

It is desirable that the present question as regards the presidency of the Institution should be thoroughly understood by all.

The feeling that the president, head as he is of the electrical profession during his tenure of office, should be either a thoroughly representative practising engineer or an electrical scientist, who, by solid work has gained real pre-eminence, is of no recent origin. It has been much discussed amongst members, both in London and in the provinces, for several years past. Many members of the council themselves entertain it, and if others were until recently unaware of its existence and strength, this is only an instance of how greatly some are out of touch with the sentiments of those whom they are supposed to represent.

Except under special circumstances, when, as is at present the case, some species of organisation is arranged beforehand, the election of officers is a purely nominal proceeding and must be so according to the manner in which nominations and voting are at present conducted. The council are in name elected by the members and associates, but in reality by themselves. New members of council, as also the higher officers, are nominated entirely by the council of whom a yearly increasing majority are perpetual past-presidents. The council's nominations are kept secret until the ballot papers are actually issued, a few days only before the voting takes place. There is then no time for members to take any combined action, and mere disagreement with the council's list can have no effect. The council have created a custom whereby the senior vice-president is always nominated for the presidency. while the ordinary members have no real voice as to the initial election of the men who thus eventually step by a purely automatic process into the presidential chair.

Everyone must agree that the existing arrangements are highly unsatisfactory. The president of a scientific or engineering institution should be the choice not of a minority, not even of a majority, but should be acceptable to the whole of the members.

Sir David Salomons has been put in a most unfortunate and unenviable position by the council of the Institution. He will, I am sure, give those who are opposing his election to the presidency credit for entirely impersonal and disinterested motives. They have only the interests of the profession and of the Institution itself at heart. The sacrifice that he is asked to make is not inconsiderable in itself. By making it he will be rescuing the council, to whose actions he owes his present difficulties, from what promises to be a serious fall. Be his decision, as also the eventual result of the election, what it may, it is clear that similar difficulties will occur again in the future, unless radical changes in the whole machinery by means of which the council and its officers are elected, are immediately carried out.

A. A. C. Swinton.

Aerial Lines.

Having erected an electric light plant and supplied light to a few of my tenants, I wish now to take the light across a road by means of an aerial line.

Will you kindly tell me through your valuable paper if there is any law to prevent me from doing this. I am not under the London County Council, but urban authority.

I have seen your replies on this subject, but none relate to my case. Thanking you in anticipation.

T. E. Ryan.

[Our correspondent will need to gain the consent of the road authorities before he can erect an aerial line.—Eds. Elec. Rev.]

LEGAL.

Crompton Electric Supply Company of Australia, Limited.

Mr. Justice Kekewich, sitting in the Chancery Division of the High Court of Justice, had before him, on Tuesday last, an application by Mr. Butcher, counsel for the plaintiffs in the case of W. G. Whiffen, suing on behalf of himself and all other holders of preferred debentures in the Crompton Electric Supply Company of Australia, Limited, and, with him, Crompton & Co., Limited, suing on behalf of themselves and all other 1st mortgage debenture holders, against the Crompton Electric Supply Company of Australia, Limited, and the Crompton-Howell Electric Storage Company, Limited.

The Supply Company was incorporated in 1889 to carry out electric lighting schemes in Australia, and of £15,000 7 per cent. debentures it issued, Whiffen held £200, and Crompton & Co., Limited, £9,500. In 1894, the company issued £5,120 second mortgage 7 per cent. debentures, of which Crompton & Co. held £5,000, and the Crompton-Howell Storage Company £120. They further issued £3,000 preferred 7 per cent. mortgage debentures, of which Whiffen held one to cover £500 and interest. The principal having become payable in default of the interest being met, plaintiffs in April last applied for, and obtained, a declaration of their charge, and the appointment as receiver and manager of Mr. F. R. Reeves, of Mansion House Buildings, City, secretary of Crompton & Co., Limited, as receiver and manager until October 31st last; and that order Mr. Justice Stirling had extended until to-day. The application now was—Mr. Butcher saying that Mr. Witton and Mr. Rowden appeared for holders of other debentures, and the defendant company were also represented—that the time for the exercise of the receiver's and manager's powers might be extended, negotiations being in progress by which it was hoped the business would be sold. Mr. Carpmael, for the company, saying they did not object, this being a going concern, that was, they were a company in liquidation; and the other counsel making no opposition,

His Lordship said he would extend the time for the receiver and manager to act until the end of April, with leave to adjourn the further consideration in Chambers; and, if need arose, he should expect to hear further of the matter before the extended date had expired. He had no idea how many limited liability concerns in this country were now under the supervision of the Court, but they must be very many; and, so far as he was concerned, he should take care that these appointments were not regarded *pro forma*, but were intended to subserve the purpose of realising all that could be obtained for the shareholders and others in whose behalf they were made.

The Fareham Electric Light Company *v.* the Fareham Urban District Council.

In the Queen's Bench Division of the High Court of Justice, on Wednesday and yesterday, this case was before the Lord Chief Justice and a special jury. This action was brought by the plaintiff company to recover damages for alleged breach of a contract entered into between the company and the Fareham Local Board (whose powers the defendants had taken over) on August 16th, 1894, by which the Local Board agreed to purchase the whole of the company's undertaking and plant at a valuation, and pay a sum of £1,000 in addition to the contract price, on condition that the company should lay certain overhead wires underground, and should, further, purchase a new engine. The contract was to be subject to the consent of the Board of Trade and of the Local Government Board, the company undertaking to use their best endeavours to get the consent of the Board of Trade, and the Local Board undertaking to use their best endeavours to get the consent of the Local Government Board, which was necessary in order to enable the local body to obtain a loan.

The defence was that the resolution was not properly passed, certain members interested in the plaintiff company having voted, and that the consent of the Local Government Board had not been obtained. But it was admitted in the course of the case that there had been a breach of the obligation on the defendants to use their best endeavours to obtain the consent of the Local Government Board to the purchase and the making of a loan, and that the question became one of damages. Having regard to the fact that the ratepayers were against the purchase, and the circumstance of the case, it was submitted that the defendants were justified in acting as they had done.

Yesterday afternoon the jury found a verdict for the plaintiff, damages £3,800. Stay of execution was granted until January 15th.

Edison & Swan *v.* Strauss.

An action, in which the Edison & Swan United Electric Light Company, Limited, are plaintiffs, and Gustav Strauss, of Queen Victoria Street, City, is defendant, came before Mr. Justice Kekewich on Thursday (yesterday), Mr. Jackson, on the part of the defendant, asking that the action should be dismissed as being vexatious, or, in the alternative, that it should be held the statement of claim was embarrassing.

The substance of a long discussion of the matter between Mr. Jackson and Mr. Graham (who appeared for the Edison Company), was that at the end of July Mr. Justice Stirling had before him an action between these parties to restrain the alleged infringement of plaintiffs' patent in sockets and holders for electric lights, by his buying and selling them. Defendant in that application, finding that he had done wrong, consented to a perpetual injunction, and to pay damages and costs as to part of the infringement, but he denied the other part. Although he had paid the costs, there followed the statement of claim, now objected to as "hopelessly embarrassing."

Mr. Graham submitted that the application must be dismissed. The present complaint was made under the Trade Marks Act, and related not to the matters embraced in the perpetual injunction to which defendant had consented, but to other things.

His Lordship: That he allows discount and so forth, I see.

Mr. Graham: That is the infringement of our letters patent. We allow parties to sell under license in the open market, but only on certain terms and prices, and we charge defendant with having allowed 45 per cent. discount, when it was by arrangement with us that he should only allow 35.

His Lordship: That does not meet my suggestion that the relief you ask for hangs on no definite allegation; you ask relief, but your claim is a prayer rather than a detailed claim.

Mr. Graham: I submit that, at all events, your Lordship will not prevent the action from going on. If you think we can give clearer

particulars we should not object, but I really don't see how we can give more specific details than we have done. I hope you won't rule that there is no cause of action.

His Lordship: Of course not. All I want you is definitely to say in your statement of claim what you complain of; but you don't do this. On condition that you comply with this view, I shall make no order on this motion, except that costs be costs in the action.

Mr. Graham: We will adopt your Lordship's suggestion.

BUSINESS NOTICES, &c.

Auction Sale.—On Thursday, December 5th, Messrs. Wheatley Kirk, Price & Goulty will sell, in accordance with instructions received from Messrs. Russell & Co., of 11, Queen Victoria Street, E.C., the entire contents of that company's works at 45, Broadway, Walham Green, S.W., comprising gas engine, compound-wound dynamos, lathe, inverted arc lamps, resistance coils, electroliers, incandescent lamps, cable, accumulators, &c. Catalogues on application to Messrs. Russell, or the auctioneers.

Change of Address.—The offices of our contemporary, *Electricity*, and of Mr. Sidney Rentell, have been moved to more commodious premises at 11, Ludgate Hill, E.C.

Christmas Numbers.—The Christmas number of *Yule Tide* is full of lively and interesting matter. *Science Siftings* special number will be found useful by those anxious to interest Christmas gatherings with simple and scientific experiments.

Crompton's Fire.—Messrs. Crompton ask us to state in regard to the fire at their works that the Electrical Heating and Cooking Department is not affected, as the London works are alone employed in the manufacture of this apparatus.

Liquidation Proceedings.—The public examination of directors and officers of the New British Electrical Installation Contractors, Limited, was opened on Wednesday, last week, at the Worcester County Court, and adjourned until December 18th.

Price Lists.—The North British Wire Manufacturing Company, of Fleet Street, E.C., has sent us a price list of bell, telephone and instrument wires, and flexible cords, also a price list of dynamo brushes.

Messrs. J. H. Heathman & Co. have also sent us a set of their lists of extension ladders and other specialities.

"Quanonne" Lamps.—We hear that Messrs. A. & W. Hopkins, of Parliament Street, S.W., have secured a large contract for the supply of "Quanonne" lamps to Messrs. Spiers & Pond during the coming year.

Rival Aluminium Companies.—"Chemist," in a letter to the *Financial News* regarding the Electro-Chemical Company (the report of whose meeting we published in our last issue), says:—"The *Money Market Review* of the 16th inst. commends the Electro-Chemical Company to public notice, and gives a report of the chairman's speech. Copies of that journal have been sent anonymously, with an obvious motive, to various shareholders of the rival Aluminium Company. Will you, therefore, kindly allow me to point out some errors and omissions in the speech of the chairman, Colonel J. T. Holland, C.B., who is a retired officer of the Bombay army, not of the Royal Engineers, as reported? He says that his company uses cheap iron cathodes, and that the Aluminium Company makes them of mercury. The fact is that the Aluminium Company does use iron cathodes, and, in addition, employs mercury, but not as a cathode. The Colonel suggests that the mercury volatilises with deadly effects in the Aluminium Company's process (Castner's). That process is not experimental, as he suggests, but has been worked on a large scale, with 100 H.P., for over a year, without any appreciable, or even possible, volatilisation of mercury. There is a mechanical loss of mercury, but it amounts to less than 2 per cent. per annum—a figure which will probably be much reduced. Colonel Holland declares that the Castner machinery is surrounded night and day, not only by the deadly fumes of mercury, but by the corrosive chlorine gas, while his own process operates in a pure atmosphere. The truth is that both processes necessarily produce chlorine gas, and in both it is conveyed away, without serious trouble, to the quicklime, which absorbs it, forming bleaching powder. Colonel Holland should have informed the shareholders that his caustic soda contains about 10 per cent. of salt, whereas Castner's is pure—a difference which soapboilers and others will appreciate apart from the question of cost, into which I cannot enter; but the assurances given to the Aluminium Company's shareholders by the Right Hon. J. Balfour and Sir H. Roscoe are unequivocal. Colonel Holland has, I believe, never inspected the Castner factory, nor has its caustic soda been publicly sold, as the whole product, having a purity elsewhere unattainable, is used with great profit in the manufacture of metallic sodium."

This letter is followed by another in a later issue, signed by "Fair Play," who says:—"I do not propose to go into all the statements made by 'Chemist' in his letter published in your Friday's issue, because some of them have nothing to do with the electrolytic processes of either the Electro-Chemical or the Aluminium Company, and some of them he has saved me the trouble of contradicting by contradicting them himself; but, as one much interested in alkali and alkali manufacture, I cannot let his letter pass without saying that I am satisfied that the caustic soda made by the Electro-Chemical Company, and now in use in many factories in Lancashire and elsewhere, contains no undecomposed salt whatever, and is, I believe, as pure as can be made. It is certainly purer than any I have ever seen manufactured by any other process, and doubtless it is on this account that it has already obtained, and is obtaining, such a large sale, and several repeat orders from soapboilers and others. As to the quality of the Aluminium Company's caustic soda, it may or may not prove all that 'Chemist,' who is evidently interested in that company, tries to make out it will do; but at present we have nothing to enable us to form an opinion about it, except the prophecies of interested parties; for, as 'Chemist' admits, none has yet been made, nor, I believe, any bleach—none has, anyhow, reached the alkali markets of England, whereas many hundreds, if not thousands, of tons of Electro-Chemical caustic soda and bleach have been sold in Lancashire alone, and I hear their whole output for 1896 has been bought up in advance."

Ritter & Puzey v. Bolas.—This action came on for hearing at the City of London Court, before the Assistant Judge, on Monday last. Mr. Elliot was counsel for the plaintiffs, and Mr. Craig for the defendant. The plaintiffs, the proprietors of the Cannon Street Hotel, sued the defendant for the sum of £7 19s. (?) for providing certain electrical power to his order. The silver wedding of Mr. H. Marks was celebrated at plaintiffs' establishment in July last, and on that occasion, according to the plaintiffs' case, the defendant asked if he might photograph the guests. To do that it was necessary for some electrical power to be supplied to work a lamp. That the plaintiffs supplied to the defendant, who now declined to pay for it. The defence was that the defendant went to the hotel at the plaintiffs' suggestion, and the plaintiffs said they would be content if they were presented with a copy of the photographs which were to be taken. This was denied, and the case was adjourned for a trial before a jury.

The "Pritchett" Accumulators.—These accumulators, which are of the Planté type, are being introduced by Messrs. Pritchetts & Gold, and are stated to be the result of over six years' experimenting. It is claimed that the construction of the plates is such, that they are capable of being discharged at very heavy rates, without causing buckling or loss of active material. The plates are said to be very strong mechanically, and contain a large core of solid

lead, and it is claimed that their capacity will increase with use. The formation is effected by a special process, and we are informed results in a perfect electrical connection between the active material and the core. A special feature claimed is the method of connecting the plates to the contact lug. By the means adopted, any positive plate can be removed, and a new one substituted, without it being necessary to take the section out of the acid. The illustration shows a 15-plate cell.

ELECTRIC LIGHTING NOTES.

Bangor.—The ratepayers have again met and discussed the proposed electric lighting scheme, and have decided to attend, by deputation, the Local Government Board inquiry and oppose the proposal.

Bermondsey.—The Vestry has decided to oppose the application of the Capital and Counties Electric Supply Company for a provisional order.

Bradford.—On the occasion of an Oriental Bazaar at the Central Hall, Manchester Road, last week, the rooms and stalls were lighted with electricity by Mr. G. A. Stienthal.

Camberwell.—The Vestry, the other day, discussed the electric lighting question. A company thought of applying for a provisional order, but the Vestry decided, by 48 to 35 votes, "That the assignment of a monopoly of electric lighting in this great and growing parish to a private company for so great a period as 42 years, demands such grave consideration, that the Vestry hereby appoints a special committee to consider and report upon the question of the lighting of the parish in all its bearings."

Cairo.—On Saturday evening, October 26th, the official test of the electric light at the Khedivial Opera House in Cairo took place. Messrs. Nahman & Co., electrical engineers, have entered into a contract with the Government to light the theatre for a period of 10 years. The installation has been carried out during the past summer under the personal supervision of Mr. A. E. Levin, A.I.E.E.

Cardiff.—The Electrical Committee, having in view the large number of arc and incandescent lights wanted for the forthcoming exhibition, had under consideration at their meeting on Monday the question of whether the Corporation supply plant should be extended, and the whole question was referred to a sub-committee. It was stated that further orders for private lighting could not be taken until the plant was extended.

Dundee.—Mr. F. J. Warden Stevens has offered to place his services at the disposal of the Harbour Trustees with regard to a system of electric lighting.

Elland.—The *Halifax Guardian* says there is a feeling abroad that the electric light should be introduced into this district, and a movement is on foot to bring weight to bear upon the Council.

Edinburgh.—The Town Council has agreed to extend the installation of the electric light for the public lighting from the General Post Office to Regent Terrace.

Folkestone.—The latest move in electric lighting here is the decision of the Town Council, on 21st inst., to apply for a provisional order, so as to keep the powers in its own hands.

Kettering.—After a prolonged discussion, the District Council last week decided to apply for a provisional order. The motion was only carried by a majority of two votes.

Lambeth.—By 32 votes to 25, the Vestry has decided to appoint a committee to consider carefully all the information obtainable on the electric lighting question, and report.

Limerick.—The Electric Lighting Committee have issued to the citizens a statement illustrating the relative cost of domestic lighting by gas and electricity.

London.—The County of London and Brush Company recently wrote to the St. Luke's Vestry proposing to light the public thoroughfares of the parish. The Vestry discussed the matter, and the chairman stated they might have the light at the Vestry Hall when the installation was fully established in the parish.

Mevagissey.—A company is to be registered for lighting the district by electricity. A good number of shares have already been applied for locally.

Rochdale.—The Borough Surveyor has prepared a scheme for lighting the Library by electricity, a small gas engine being set down. The cost is estimated at £400.

St. James's and Pall Mall Electric Light Company.—We hear that the recent issue of 4 per cent. debenture stock of the St. James's and Pall Mall Electric Light Company, Limited, offered to the shareholders of the company at 2½ per cent. premium, was largely over-subscribed.

Tottenham.—A committee of the Council has recommended that an expert consider the question of the introduction of an installation of electric light for the district. A member has given notice to move that the Council invite electrical engineers to submit schemes and estimates, premiums to be offered for the first three schemes selected.

Wakefield.—The Corporation having applied for powers to borrow £25,000 for the proposed electric lighting works, a public inquiry is to be held on the subject at the Town Hall to-day.

Worcester.—Plans and specifications for the installation of electric light at the Market House have been submitted to the Markets Committee. The estimate of the cost by Mr. Murray, the electrical engineer, is:—Brush Vienna arc lamps, £76 10s.; hoisting gear, £11; wiring, fixing, and hanging lamps, £65. Mr. Murray has further reported that the cost of gas lighting, estimated at 2,800 candle-power, was 1s. 11½d. per hour, and the cost of electric lighting, at 20,000 candle-power, would be 2s. 3½d. per hour. The Committee decided to advertise for tenders for the work.

Wells.—Negotiations with the Gas Company for the purchase of their undertaking having fallen through, the Council has resolved to apply for a provisional order for electric lighting.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Electric Traction in Switzerland.—Work is at present in hand on the construction of an electric tramway in the town of Lausanne. The generating plant at the power station will consist of two Thury dynamos, each giving 150 ampères at 550 volts, driven by two Crossley tandem gas engines of 130 H.P.

Electric Cranes in France.—A large new electric crane has just been erected on the quay at Boulogne for the purpose of transferring luggage from the trains to the steamers.

Electric Traction in Germany.—The new electric tramway, which has been constructed between Barmen and Wichlinghausen by Messrs. Siemens & Halske, of Berlin, has just been opened for traffic. The electric traction question at Liegnitz has been given up in favour of a scheme for a gas tramway.

Fatal Accident.—On Saturday night a watchman engaged on the Dublin Southern District Electric Tramway Works, fell into a trench about 6 feet deep, where he was found quite dead at 7.30 a.m. the following day.

Light Railways.—Convened by Mr. Scratchley, secretary, a small but representative meeting of commercial men and others interested in the subject was held on Wednesday morning at 17, Victoria Street, Westminster, for the purpose of discussing the desirability of forming a Light Railways Association, and the lines upon which it should be established. The chair was taken by Mr. W. J. Carruthers-Wain, the president of the Tramways Institute, and amongst those present were Major-General Hutchinson, Major-General Webber, &c. The chairman, in opening the proceedings, mentioned that he had recently returned from America, where he had been studying the question of the working of light railways in that country. In conjunction with several other persons of commercial knowledge, he had gathered a good deal of information on the subject, which he and they would be happy to place at the disposal of the committee which they proposed to form at that meeting. He then moved formally a resolution which recommended that a Light Railway Association should be formed. This proposition, having been seconded by Major-General Webber, was unanimously agreed to. The meeting then considered the advisability of appointing a committee, and, after some discussion, the following names were suggested as a provisional committee, assuming the gentlemen nominated will consent to act:—The Duke of Sutherland, Lord Wantage, Major-General Hutchinson, Mr. Alderman Beachcroft, L.C.C., Sir Douglas Fox, Major Rasch, M.P., Major-General Webber, Mr. Carruthers-Wain, Mr. A. C. Payne, Mr. Hamilton Smythe, Mr. Harding Milward, Dr. Carte, and Mr. W. Murphy (Dublin). The representatives of the Press were then requested to retire, and the meeting proceeded to consider in private the various details connected with the scheme and the lines upon which the association shall be conducted in the future.

Newcastle Tramways.—A public meeting was held at Newcastle on 22nd inst. to protest against the Corporation's recent decision in favour of the cable system, and granting powers to the company for 21 years. The meeting protested against the length of the lease, and thought the Corporation should have kept the powers in its own hands.

Portsmouth and Electric Tramways.—We understand that the Provincial Tramways Company intend to apply for Parliamentary sanction for the use of electricity on the Portsmouth tramways. The Bill will authorise the company to sell to the Corporation or to use the electric current supplied by the Corporation.

South Staffordshire Tramways.—The *Birmingham Argus* has it "on good authority" that the extension of time made to the above-mentioned company to the end of the year will be final, seeing that a special offer has been made to buy out the whole concern and equip the line from the New Inns to Carter's Green with the cable service, and that from Carter's Green to Wednesbury, Great Bridge, and Dudley with the electric system. An offer has been made on behalf of a syndicate to the Town Councils of Wednesbury, and West Bromwich, and Tipton District Council on behalf of the interested company, and it is understood that it will meet with acceptance.

The Last Horse Car at Detroit.—A Chicago paper says that the last horse car in Detroit made its trip on November 9th, and the car was broken up by relic seekers. Quite a ceremony attended the obsequies, and the campus in front of the city hall was crowded with people. Vice-President Hutchins told of the Citizens' Company's promise to have electric cars on all its lines before snow fell this fall, and the old car from Chene Street was the last of its kind. The team was auctioned off, and brought $100. The money is to go into the Mayor's fund for the relief of explosion sufferers.

Tramcar Accident.—A Reuter despatch from Marseilles says that a serious accident occurred on the electric tramway there on Tuesday. A car with a full complement of passengers was proceeding to St. Louis, when it came into collision with a waggon heavily laden with lead. The back part of the waggon crashed into the front of the car, which was greatly damaged. A number of passengers were injured, eight seriously.

Tramcar Motors.—The Leith Town Council sent a deputation to Glasgow, the other day, to inspect the Johnston mechanical tramcar motor.

TELEGRAPH AND TELEPHONE NOTES.

"Fastnet" Rock.—The paragraph which has recently appeared in many of the daily papers relating to the breaking of the Fastnet Lighthouse and Crookhaven cable is somewhat misleading. The communication is effected by means of the non-continuous cable system first suggested by the late Mr. Willoughby Smith, and has worked satisfactorily for over four months. The system necessitates two short lengths of strong bare copper cable being bolted to the rock from the lighthouse to the water's edge, and this can only be

done when the sea is exceptionally smooth—a very rare thing at the Fastnet. Owing, however, to the persistent bad weather, the cable down the north face of the rock could not be absolutely secured, and has, therefore, given way. Communication can be, and has been, maintained, except in the very roughest weather, by means of a temporary copper wire which the lighthouse men throw over the side of the rock, so that the end just enters the water. The main cable, about 9 miles long, which terminates at a mushroom submerged in the vicinity of the rock at a depth of about 80 feet, still remains in perfect order.

New Cable Ship.—Sir Westby Perceval, the Agent-General for the New Zealand Government, has placed an order with Messrs. D. J. Dunlop & Co., of Port Glasgow, for a new twin-screw steel steamship, to be used primarily for the laying and repairing of the New Zealand Government telegraph cables; but also intended at times for other services, such as the conveyance of the Governor and his suite, lighthouse and buoy work, &c. The principal dimensions of the vessel are to be:—Length between perpendiculars, 205 feet; breadth, 30 feet; depth of hold, 15 feet; mean draught when loaded with a load of 580 tons, in addition to the cable machinery, and full equipment of stores, 13 feet 7 inches. She will have two cable tanks, one fore and one main, the two together having a capacity sufficient for the storage of 86 knots of cable, 1⅜-inch diameter. The cable machinery will be supplied by Messrs. Johnson & Phillips, of Charlton, and be of their latest design. There will be two sets of triple expansion condensing engines, working with an initial pressure of 170 lbs. to the square inch. These engines, together, are to be powerful enough to drive the vessel at a speed of 14 knots per hour. with bunkers full, and full ship's equipment on board. The coal bunkers will carry 130 tons of coal. The vessel will be fitted throughout with the electric light, about 90 glow lamps of 16 and 50 candle-power being required. The contract contemplates the delivery of the ship complete, with trials passed, in April next. She is to be named the *Teriha*.

New Submarine Cable.—The French Government telegraph steamer, *La Charente*, has successfully laid a submarine cable between Massowah and Djibouti, in the Red Sea. The cable was manufactured at the Government factory at La Seyne.

Interruption of the Indo-European Landline.—From a Berne notice we gather that the above route is stated to have been interrupted; the official telegram is dated 23rd ult., the notice of repair being dated the 24th.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—Tenders are invited by Messrs. P. & F. M'Glade for supplying and fixing electric plant for lighting their new premises, the "International," York Street. Particulars from George Combe & Co., Consulting Engineers, Castle Lane Place, Belfast.

Brazil.—January 25th, 1896. The Minister of Industry of the State of Pernambuco is inviting schemes for the electric lighting of the town of Recife in that State.

Blackburn.—November 30th. The Corporation invite tenders for alternators, transformers, switchboards, &c.

Belgium.—January 15th, 1896. The Belgian Minister of War is inviting tenders for the contract for an installation of electric lighting in the new military school in the Avenue de la Renaissance in Brussels. Tenders to the Ministère de la Guerre, Brussels.

Chili.—December 5th. Tenders are invited for the manufacture and laying of a submarine telegraph cable from Puerto Montt to Punta Arenas. The conditions and specifications may be consulted in the Chilian Legation, Member's Mansions, 36, Victoria Street, S.W.

London.—December 10th. The Secretary of State for India is prepared to receive tenders for the following among other materials:—Caissons, air compressing and electric light plant. The conditions of contract may be obtained on application to the Director-General of Stores, India Office, Whitehall, S.W.

Manchester.—December 2nd. The Corporation invites tenders for two dynamos for the Foreign Animal's Wharf, Mode Wheel. Particulars from the City Surveyor, Town Hall.

Ryhope.—November 30th. The Ryhope and Silksworth Industrial and Provident Society, Limited, are prepared to receive tenders for the supplying and fixing accumulators in connection with their Ryhope Electrical Installation. Particulars given at the Store, Ryhope.

Spain.—December 28th. Tenders are being invited by the municipal authorities of Betanzos, a small seaport town in Galicia, for the concession for the electric lighting of the town during a period of twenty-five years. Tenders to be directed to El Ayuntamiento de Betanzos, Spain.

Swansea.—December 6th. Tenders are invited for supply and erection of plant for electric lighting and dust destruction for the Corporation.

Windsor.—January 1st, 1896. The Corporation invites proposals for taking over and working their electric lighting orders. All proposals to include the erection and maintenance of a generating station upon a specified site, laying down mains, and necessary equipments, with a constant supply of electricity for lighting purposes in the stated area. Details to be obtained from the Town Clerk, Windsor.

Warrington.—November 30th. The Cheshire Lines Committee invite tenders for the supply, during the year 1896, of various stores, among which are the following items:—Iron bars, sheets and plates, spike iron, &c.; telegraph materials, instruments, wire, &c.; wrought-iron tubing, point rodding, point rollers and standards, lead piping, and sheet lead; wrought-iron bolts, chain, &c.; galvanised sheets, signal wire, pulleys, stay-rods, screw-spikes, zinc sheets, &c. Particulars from Mr. Saxon Barton, storekeeper, Cheshire Lines, Warrington.

CLOSED.

Brook Hospital.—At the fortnightly meeting of the Metropolitan Asylums Board, on Saturday, the Brook Hospital Committee submitted the following list of tenders received for the supply of engines and dynamos, switchboards, and batteries, in connection with the electric lighting of Brook Hospital:—

	Engines, dynamos, &c.	Switchboards.	Batteries.
Siemens Bros. & Co.	£2,004	£527	£475
W. H. Allen & Co.	2,060	—	—
J. H. Holmes & Co.	2,100	350	475
Crompton & Co	2,139	366	551
Electric Construction Co.	2,142	370	509
Johnson & Phillips	2,170	630	360
Thos. Parker, Limited	2,312	412	521
Brush Electrical Engineering Co.	2,428	480	378
Mather & Platt	2,605	415	465

The Board accepted the tenders of Messrs. Siemens Bros. & Co. for the supply of engines, dynamos, and batteries, and of Messrs. J. H. Holmes & Co. for the switchboards.

The following tenders were sent in for the work of wiring and fittings for Brook Hospital and ambulance station:—

Firm.	Brook Hospital.	Brook Ambulance Station.	Total.
	£ s. d.	£ s. d.	£ s. d.
Electrical and General Engineering Co.	3,169 10 0	289 0 0	3,458 10 0
Brush Electrical Engineering Co., Ltd.	4,547 0 0	192 0 0	4,739 0 0
Julius Sax & Co., Limited	4,666 8 4	213 9 11	4,879 18 3
Fowler, Lancaster, & Co., Limited ..	4,685 12 6	228 0 0	4,913 12 6
Edmundson's, Limited	4,643 19 0	350 15 0	4,994 14 0
Strode & Co.	4,878 0 0	334 0 0	5,212 0 0
Prichetts & Gold	5,279 10 0	289 0 0	5,568 10 0
Cecil Nathan	5,063 0 0	630 0 0	5,693 0 0
Henry F. Joel & Co.	5,954 0 0	336 0 0	6,290 0 0
Hollingum & Saword Co.	6,179 0 0	400 2 6	6,579 2 6
Slaters, Limited	6,217 0 0	534 0 0	6,751 0 0

The Board accepted the tender of J. Sax & Co. at £4,879 18s. 3d.

Worcester.—The City Council has decided to fix an apparatus, with McDougall's patent steam traps, for heating the Powick Generating Station, at a cost of £70 5s., to purchase from the Brush Company one 18 K W transformer at £58 16s. 6d., and to accept the tender of Messrs. Korting Bros. to provide and fix a condensing plant at the Powick Generating Station at £430, also to spend a further sum of £28 in providing for live steam connection to the pumping engine, piling, &c.

NOTES.

Horseless Carriages.—Sir David Salomons announces a meeting for the purpose of forming an association in connection with self-propelled traffic, to be held on Tuesday, December 10th, at the Cannon Street Hotel, at 3 o'clock. He considers it is now necessary to turn to business. He states that he has secured powerful support in this movement, and it is likely that many gentleman well known in public life, and influential in other spheres, will be present. "I have agreed to take the chair, and shall submit to the meeting a series of resolutions with a view of making a start. Capitalists, inventors, and users are all ready for the moment that Parliament affords the necessary facilities for this class of traffic, and the trade is likely to become a very important one to England. Mr. Andrew Barr, of 30, Moorgate Street, London, E.C., is kindly acting as honorary secretary for the time being. Tickets may be obtained for the meeting by applying to that gentleman."

A New System of Train Lighting.—Along with representatives of other newspapers, and a few engineers, we had the privilege on Wednesday night of travelling in an electrically lighted train on the Tilbury and Southend Railway. The journey extended to Grays, and back, both journeys being done without a stop. The company were afterwards entertained at dinner at the Holborn Restaurant by Messrs. J. Stone & Co., of Deptford, who are working this new system. The method, which has been devised by Mr. Albert B. Gill, and adopted by Messrs. Stone, is practically the suspending of a dynamo under each railway carriage, and driving it from the axle by means of a belt. When the belt is on the dynamo is pulled slightly out of the vertical position it assumes by reason of its own weight and that of a counterpoise, the pulling effect thereby obtained tends to keep the belt in tension. In conjunction with the dynamo is a set of eight E.P.S. cells, which supply the lamp circuit when the train is at rest, or when its speed is less than 10 miles an hour. When this speed is attained the lighting is taken up by the dynamo, the cells being in connection with it and the lamps. This is no doubt effected by some form of make and break which we did not see. An important claim is made with regard to the running of the dynamo. We were told that at from 10 to 20 miles an hour there will be a slight variation in the speed of the machine, but after 20 miles an hour the speed remains constant, the extra momentum being taken up in the slip of the belt; thus the lamps practically receive the same current at all speeds. This seems to us to be a curious thing; it is, at any rate, difficult to appreciate that the slip of the belt at speeds ranging from 20 to 40 miles an hour is a constant factor under such variable and onerous conditions as obtain in railway travelling. We must hasten to say this, however, that there were very few fluctuations in the light throughout the whole journey, and those occurred when the train was slackening or increasing speed, thereby, we presume, putting the accumulators in or out of circuit, but so far as the constant running of the dynamo with the very dubious regulation of a shifting belt is concerned, there was no evidence to show that there is any such regulation. The constancy of the light could easily be explained if we look upon the accumulator as the regulator for any fluctuations of dynamo speed. Though the journey was no doubt a fair distance test, we should have preferred that there had been one or two stoppages just to test the changing-over arrangement. There was no opportunity of examining the apparatus, however, and in saying what we have done we are relying entirely on the information supplied to us. Perhaps we may have an opportunity of examining the apparatus on a future occasion. There was an important point on which it was impossible to obtain information, that is the question of maintenance. It seems to us that on a train of 12 coaches, which would necessitate 12 small dynamos and 12 sets of accumulators, the repairs and maintenance would be fairly considerable during 12 months. A train moving at 40 or 50 miles an hour must have a rather rapid deteriorating effect on accumulator plates; and another point, of minor importance, perhaps, but worth considering, is whether on a 12-coach train, with 12 small dynamos, there is not some slight danger of a hot bearing on one of the machines. The oil supply to the bearings is done automatically; it may fail automatically, and as the machines are completely boxed in, such a failure would not be easy to discover. We do not know precisely what might happen under such circumstances, but it is obvious that the event would possess an element of a mishap. However, we understand that there are to be extensive trials on other lines than the Tilbury and Southend, and some of these questions will be no doubt answered. We believe that the cost of equipping a coach with this system is about £50, therefore to equip a train of twelve coaches would cost about £600. Two small lamps, 16 volts, are used for each compartment, and they are arranged on different circuits.

Obituary.—We regret to announce the death of Mr. John Muirhead, which took place on the morning of the 21st inst. Mr. Muirhead was for many years identified with the firm of Latimer Clark, Muirhead & Co., and was perhaps best known as patentee of the "gridiron" condenser, &c., now almost universally employed in the duplexing of submarine cables.

Lectures and Papers.—Before the Institution of Junior Engineers on Friday, December 6th, 8 p.m., at the Westminster Palace Hotel, a paper on "Considerations with respect to Water, Gas, and Electric Mains, &c., in Connection with the Formation of Urban Roads and Footways," will be read by Mr. J. Julian, of the Borough Engineer's Office, Cambridge.

Before the Royal Society, yesterday (Thursday, November 28th), papers were read as follows:—J. P. Kuenen and W. W. Randall, on "The Expansion of Argon and of Helium as compared with that of Air and Hydrogen." A. Kellas, on "The Percentage of Argon in Respired Air." A. Kellas and Prof. Ramsay, F.R.S., on "Examination of Gases from Certain Mineral Waters."

On Monday, December 2nd, Mr. Worby Beaumont will commence at the Society of Arts a course of three Cantor lectures on the subject of "Mechanical Road Carriages." The first lecture will deal principally with the history of the subject, the second with general principles, and the third with an account of the more recent efforts which have been made to develop a system of mechanical vehicles for common roads.

At Hull, on 19th inst., under the auspices of the Hull Literary and Philosophical Society, Prof. J. A. Fleming lectured upon "Appliances of Electricity."

The Chelmsford Fire.—If electrical engineers and supply companies cannot keep their own buildings free from risk of fire, the would-be consumer will think twice before having his house fitted with electric light and heating apparatus, notwithstanding the immunity from danger supposed to be ensured, if due regard is paid to the rules and regulations of insurance companies and others. Moreover, it seems certain that these frequently recurring disasters will affect the future insurance of electric supply buildings. If Mr. Crompton's theory, expressed in the columns of a contemporary, as to the cause of fires in electricity works, is really that gentleman's honest belief, we cannot say that the placing away in pigeon holes of materials "liable to spontaneous combustion, or at least to take fire on the smallest possible provocation," is calculated to make one's mind easy on this very important point. It is one thing to advance a "theory" in conversation and another to see it in black and white, and it is inconceivable to us that Mr. Crompton should have so given himself away. Surely this is one of the things best left unsaid, and if not immediately repudiated by other suppliers of electrical energy, we have mistaken our men.

New Journal.—The first number of the *Popular Science Monthly* (November), published by Messrs. Kegan Paul and Co., contains an interesting variety of articles on scientific subjects, and the journal should have a good future before it. The price is 2s. 6d. per copy.

Heriot-Watt College Professorship.—For the position of Professor of Applied Physics and Electrical Engineering in the Heriot-Watt College 17 applications have been received.

The Royal Electric Company of Montreal.—This company announces an issue of £34,000 4½ per cent. first mortgage debentures, redeemable by annual drawings at 105, or earlier, at the option of the company, on six months' notice, at 110. The issue price was 105.

The City of London Electric Lighting Company, Limited.—This company is issuing a 5 per cent. debenture stock to the extent of £100,000. Full details will be obtained from our advertisement columns.

TRAFFIC RECEIPTS.

The Bristol Tramways Company. The receipts for last week show an increase of £345.

The City and South London Railway Company. The receipts for the week ending November 24th, 1895, **amounted to £946; week ending** November 25th, 1894, **£957; decrease, £11: total receipts for half-year, 1895, £18,562; corresponding period, 1894, £18,648; decrease, £86.**

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending November 24th, 1895, amounted to £1,067; corresponding week last year, £913; increase, £154.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 22nd, 1895, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,049.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation Nov. 20th.	Closing Quotation, Nov. 27th.	Business done during week ended Nov. 27th, 1895. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	£ s 100	...	4 %	4 %	101 —105	101 —105	...	...
1,912,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	43 — 45	44 — 46	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	82½ — 83½	84½ — 85½	84	82½
2,993,560£	Do. do. Defd.	Stock	...	...	...	6 — 6⅝	6½ — 7	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	13 — 13½	13 — 13½	13⅜	13½
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3¼ — 3⅜	3¼ — 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	164 —168	164 —168	...	...
224,850	Consolidated Telgp. Const. and Main., Ltd.	10/-	2 % §	2 % §	1½%	1/16 — 1/16	1/16 — 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	104 —107	104 —107	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅜% §	2 %	8¼ — 8⅜	8¼ — 8⅜	8¼	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½%	16 — 16½	16 — 16½	16½	15⅞
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	17½ — 18	17½ — 18	17¾	17 3/16
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	125 —128	125 —128	127	126½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17¼ — 17⅜	17 — 17½	17½	17¼
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	103 —107	102 —106	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	104 —107	103 —106	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	126 —129	126 —129	128	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	103 —107	102 —106	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	108 —111	108 —111	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	112 —115%	112 —115 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅛% §	4⅛% §	4⅛%	9⅛ — 10	9½ — 10	9⅞	9⅛
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	16 — 17	16½ — 17	16⅝	16¼
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	21½ — 22	21½ — 22	...	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	46 — 49	46 — 49	48	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	106 —110	106 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000...	5	...	...	...	2 — 2⅛xd	2 — 2⅛	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	6 — 6¼	5⅞ — 6⅛	6 1/16	6
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15½ — 16½	15½ — 16½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6¼ — 6⅜	6¼ — 6⅜	6 5/16	6¼
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —107	105 —107	106⅝	105
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4½%	9/16 — 11/16	9/16 — 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	109 —112	109 —112	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	5½ — 6½	5 — 6	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	127 —132	128	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2⅜ — 3⅛	2½ — 3	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97	92 — 97	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	*nil*	5½ — 6½	5½ — 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	102 —105	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98 —103	98 —103	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	9⅜ — 10⅛	9⅜ — 10⅛	9⅜	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6⅛ — 6⅜	6⅛ — 6⅜	6⅜	6⅛
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	3⅛ — 3⅜	3⅛ — 3⅜	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	½%	¾%	½%	⅜ — 1	⅜ — 1⅛	1	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10 — 10½	10 — 10½	10 5/16	10¼
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½ — 9½	8½ — 9½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	111 —114	111 —114	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	110 —115	110 —115	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —103	100 —103	101½	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5½ — 5⅝	5½ — 5⅝	...	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	2½%	5 %	5 %	6¾ — 7¼	6¾ — 7¼	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	116—119	115 — 118	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	12½ — 13½	13 — 13½	13½	13⅜
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15⅞ — 16¼	15⅞ — 16¼	15⅞	...
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —135	130 —136	136	132
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8½ — 9⅛	8½ — 9⅛	8 15/16	..
10,000	Do. do. do. 6% Pref., £6 pd., 40,001—50,000	10	...	...	...	8⅞ — 9¼	8½ — 9	8 15/16	8¾
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5⅛%	7⅞ — 8⅛	7⅞ — 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½ %	3 %	10½ — 11½xd	10½ — 11½	11 5/16	10¾
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —120	117 —120	118¼	117
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½ — 9½	8½ — 9	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6¾%	8 — 8⅛	8 — 8⅛	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9⅛	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	8 — 8½	8 — 8½	8⅛	8 3/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Nov. 20th.	Closing Quotation, Nov. 27th.	Business done during week ended Nov. 27th, 1895. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	6 %§	6 %§	...	1½— 1⅝	1½— 1⅝	1 5/16	1½
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %§	6 %§	...	1½— 2⅛	1½— 2⅛	1½	1⅜
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	....	...
630,000*l*	City and South London Railway	Stock	5/8%	5/8%	1¼%	40 — 42	40 — 42	..	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 %§	7 %§	...	1½— 2⅛	2 — 2⅛	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	1⅜— 2¼	1⅜— 2¼	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	...	...	...	2⅜— 3¼	2⅜— 3¼	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	...	4½%	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	*nil*	5/8— 7/8	5/8— 7/8	1 1/16	5/8
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2 — 2⅛	2 — 2 1/16xd	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	3/8— 5/8	3/8— 5/8	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	½— ¾	½— ¾	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼— ¾	¼— ¾	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½— 7½	6½— 7½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	14 — 14½	14 — 14½	...	...
3,000	Do. do. do. 7% Pref.	10	...	...	...	15½— 16½	15½— 16½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	108 —111	108 —111	108	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	18½ — 19½	18 — 19	18½	...
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	101 —103	101 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	11⅜— 11⅝	10⅞— 11	...	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15½ — 15⅝	15½— 15⅝	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	40 — 42	39 — 41	40½	39¼
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅜— 5	4⅜— 5	4⅜	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50°/ for 189

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0°/₀§; 1891—T°/₀§ 1890—8°/

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 98—102.

House-to-House Company (£5 paid), 4—4½.

Do. do. 7 % Preference, of £5, 7¾—8¼.

Do. do. 4½% Debentures of £100, 110—112.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7⅞—8¼; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7⅛.

Liverpool Electric Supply, £5 (fully paid), 7⅜—8¼

London Electric Supply Corporation, £5 Ordinary, ⅜—½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6¾—7¼.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

THE ARC LIGHT.*

By Prof. SILVANUS P. THOMPSON, D Sc., F.R.S.

Lecture II.—Delivered January 21st, 1895.

(*Concluded from page* 656.)

Alternate Current Lighting.

I have on the table here the means of producing an alternating current arc. The alternating current may be turned on, and then the arc struck by hand between the two carbons. By means of a choking coil I am able to regulate the amount of light given out by the current passing through the arc, and with this lens I will project the arc on the screen, so that you may see the difference between the normal arc, as made with a continuous current, and the alternating current arc. You will find that, in the latter case, the tips of the two carbons are heated almost equally to whiteness, and assume almost identical shapes. If the carbons are of the same quality, the heating and the consumption of them would be precisely alike, except for the slight difference due to the circumstance that the ascending hot gases around the arc make the upper carbon hotter. The two luminous areas on the two tips are of equal area and equal whiteness, and, as projected on the screen, appear as two luminous patches of equal size; but in neither the upper nor the lower carbon is there either a well-developed crater or a well-developed peak. The fact is, that each tip has to serve alternately as crater and as peak, so that the resulting form is a compromise. We are able, then, at once to recognise whether the arc is being supplied by a current that is continuous, or by one that is alternating. The distribution of light in the space surrounding the arc corresponds to this difference in the distribution of the luminous surfaces. Whereas the continuous current arc throws its light (when the crater is at the top) mainly downwards, with a maximum at 40 to 50 degrees below the horizontal, the alternate current arc throws its light almost equally upwards and downwards, there being two maxima, one above and the other below the horizontal. But with the alternate current it is possible to cause the light to be artificially projected downwards on the whole, either by placing a mirror around the upper carbon (as in fig. 12) to reflect down the light that is emitted upwards, or less advantageously, by employing a thicker top carbon, and a thinner bottom carbon. There is another important difference between the light of the alternate current arc and that of the continuous current arc, which affords a ready means of discriminating between them. The alternate current arc is subject to a regular periodic fluctuation. The rapidly reversing current pulsates, and the arc pulsates too. The current actually stops and then starts again in a reversed direction some hundred or more times in a second. The flame does not actually go out, but it dies down, and before it has had time to go out the current has started again in the opposite direction. If the flame did not thus persist, it would be impossible to operate arc lamps at all by means of alternate currents. I can show you, by a simple experiment, this fact of persistence. I take here a continuous current arc, and clamp the carbons immovably at the normal distance apart while the arc is burning steadily. Now, by means of a reversing switch, worked by hand, I suddenly reverse the current. The light blinks at the instant of reversal, but does not go out. An interruption of, say, one-hundredth of a second does not put out the light; the flame had not time to die away. It is not accurately known what the maximum duration of an interruption may be, but it is known that arc lamps cannot be practically operated with alternating currents if the frequency is less than about 40 periods per second; that is to say, if there are fewer than about 80 reversals per second. That the light of an alternate current arc does thus fluctuate can be made evident in the simplest possible way. If one whirls a white rod, or waves it rapidly up and down in the light of the arc, one perceives a succession of images. When a rod is made to throw its shadow on the screen, and is then rapidly waved to and fro, the shadow is observed to be broken up into a series of maxima. A silver coin tossed into the air shows a succession of images as it falls. By merely shaking my hand in the light of the alternating arc, I appear to possess an enormous number of fingers. The current here used is derived from the generating station at Deptford, where Mr. Ferranti's machines work with a frequency of 85 periods per second. Consequently, we have 170 successive images per second for any quick moving body. I have frequently found out whether arc lamps were worked with alternating currents, or by continuous currents, by standing under a lamp-post at night, and twirling my walking stick. You can tell an arc lamp that is alternating by another circumstance, viz., that in addition to any fizzing or hissing that there may be, you hear a kind of continuous hum. In the lamp now before you, you may hear the hum of the machines at Deptford. If I increase the current, you will hear it still more

* Cantor Lectures. From the *Journal of the Society of Arts*. References to this series of Cantor lectures will be found in the Electrical Review for January 18th and 25th, and February 1st, 1895.

loudly. The loudness of the hum also depends on the form of the individual waves of current.

Efficiency of Alternate Current Arcs.

There has been some discussion of late on the question whether the alternating current arc was as efficient as the continuous current arc, that is to say, whether for a given consumption of energy you obtain an equal proportion of light. Prof. Fleming has made measurements, and written learnedly on the subject. I do not dispute the accuracy of his observations, or that of others who had made observations on the subject. I wish to give you an absolutely *à priori* view. This is a matter I have not measured myself, therefore I am absolutely unprejudiced, but it seems to me perfectly absurd to suppose that, if you take the right mechanism, select the right size and quality of carbon, and use it properly by the light of experience, applying the appropriate amount of current, there will be any difference whatever in the efficiency of the alternating current arc and that of the continuous current arc. I do not see where there is room for any difference. At one time it was supposed that incandescent lamps were not as efficient if worked with alternating currents as with continuous currents. That heresy was long ago exploded by Profs. Ayrton and Perry, when they showed that it was merely a question of getting the right voltage appropriate to the lamp. I am bound to say I think the same kind of considerations apply here also. Since the heating effect of a current is proportional to the square of the current strength, what difference does it make, what difference can it make, whether the current is going in one direction or in another? If you spend the right amount of energy on the right amount of carbon, by raising it to the right amount of temperature, you are bound, other things being equal, to have equal results. If you arrange your things badly, so that some of the energy is not spent, as it ought to be, on heating the carbon white hot, I grant you may get a different result; but it seems to me, from *a priori* reasoning, to be absurd that you should not have equal efficiency with the alternating current as with the continuous current.

Spectrum of the Arc.

My next experiment is to project upon the screen the spectrum of the arc. Arrangements are made in the following way:—First of all, the arc is produced inside a lantern; it is then focussed by a lens upon a small auxiliary screen, 3 feet away from the arc. This screen has a narrow slit down it, the image of the arc being formed on a slit. Through the slit then there passes a vertical slice out of the arc. In this slice we shall have a bit of the top carbon, a bit of the arc in between, and a little bit of the bottom carbon—one above the other. The light of this luminous slice is then passed through a prism, and on through a focussing lens, producing on the screen a spectrum of that portion of the arc complete, from the red end on the right to the violet end on the left. Now notice what that spectrum consists of. The upper luminous streak is the white light from the crater spread out into its various component colours in their proper order, one after the other. The light of the bottom strip, which also goes from red to violet, is the light from the peak of the negative carbon. The apparently dark patch in between them shows you the spectrum of the pale flame or arc. Only those who are near can see it properly, but in this comparatively dark tract between upper and the lower carbons the spectrum shows a number of nebulous bands, two in the green, a brighter one in the bluish-green, and another one about the end of the blue or beginning of the violet. Those bands are the well-known spectra of the element carbon, so that we have here the optical proof that the flame between the two carbons consists of carbon vapour in an incandescent state.

The Enclosed Arc.

More properly belonging to the subjects comprised in my first lecture is the matter next to be mentioned of the peculiar effect produced on an arc by burning it in an enclosure which prevents access of fresh air. The properties of the enclosed arc have been investigated by Mr. Marks, to whom is due the disposition which I here exhibit. It may be fitted to any ordinary form of arc lamp. The lower carbon projects through, and supports a metal disc with a raised rim, on which stands a small glass jar about 3 inches in diameter. The upper carbon comes down into this through a rude stuffing box at the top of the jar. The arc is formed in the usual way, only it happens to be enclosed, so that the air cannot come in from below or readily pass through the rough stuffing box at the top. The air in the jar is in a few minutes deprived, by combustion, of its free oxygen; so that, from that time onwards, the arc is burning in an atmosphere that will not support combustion. As a consequence, the actual waste of carbon is much smaller than is usually the case. In some experiments on the ordinary arc, made by Mr. Preece, with a Brockie-Pell lamp, using about 6½ ampères at 50 volts, with a 13 mm. carbon for positive, and an 11 mm. carbon as negative, the mean consumption per hour per ampère was found to be, for the positive carbon, 3·52 mm. (length), or 0·504 grammes, and for the negative carbon 2·86 mm., or 0·176 grammes. (Dr. Strecker gives, as the experience in Germany, 0·75 and 0·375 grammes respectively.) Now, this consumption of carbon may, as Mr. Marks has shown, be greatly reduced by simply preventing access of fresh air.

This actual lamp has been tried. My friend, Prof. Walmsley, of Edinburgh, has been good enough to communicate to me the figures obtained during a run of 14 consecutive hours. The carbons were those ordinarily used in Brockie-Pell lamps, but the actual lamp used was of Brush-Sellon pattern. The current was 10 ampères, and the mechanism was adjusted to give a rather long arc. Of the positive rod the length consumed per pair when burning open was 47 millimetres; when enclosed only 2·84 millimetres. Of the negative carbon, the length consumed per hour, when open was 18·7 millimetres; when enclosed, only 0·62 millimetres. The positive carbon, when burnt in this way, only burns at about one-tenth of the rate at which it burns away in air, while the negative carbon only burnt away at about one-thirtieth of the rate at which it burns in free air. The total consumption, when enclosed, is, therefore, about one-twentieth part of what it would be for the same current when the arc was burning in open air. There is, however, one drawback to the use of an enclosing vessel like this; viz., that the interior of the vessel gradually becomes coated with a brown dust which obscures the light. On that Prof. Walmsley made some observations, and came to the conclusion that after eighteen hours the light was approximately about half of what it would have been without the globe. As a matter of fact, it is a brown deposit, which cuts off rather more of the green waves than it does of the red waves.

The Trotter Phenomenon.

I now come to the most recent and by far the most important of recently-discovered arc phenomena. Mr. A. P. Trotter has observed a phenomenon in the arc which has so completely changed one's ideas as to the nature of the crater surface, that one needs to reconsider everything previously learnt or observed.

When you project upon the screen by means of a good achromatic lens (such as a camera lens) an image of the arc, and adjust it so as to get a good view of the crater, a little care will enable you to discern, as often as not, somewhere in the middle of the luminous crater —not always exactly in the centre—a nebulous patch, sometimes extending in different directions. This patch is more luminous than the surrounding surface of the crater, over which it moves in a capricious way. Sometimes you can catch a glimpse of this patch revolving, flickering round and round; sometimes it goes round one way, and sometimes the other. You cannot readily observe it, however, unless you resort to artificial means, because of the rapidity of its motion. So to see it you must have recourse to the stroboscopic method. Take a simple disc of cardboard 8 or 10 inches across. Cut in this a number of equidistant narrow radial slits—say 36, 48, or 60 —and blacken the disc to obviate stray reflections. Put a pin through the centre, and fix the pin into a wooden handle. Spin the disc by hand, and watch the arc through the slits. You will then, at moments when the frequency at which the discs pass the eye corresponds to the rapidity at which the movements in the arc occur, catch sight of the moving object. A second method, suitable for projection of the phenomenon on the screen, is to mount a similar disc upon a small electrically-driven motor right in front of the arc. A suitable frequency is 400 per second, or so. A third method of observation consists in throwing the image of the arc not upon a stationary screen, but upon a revolving disc painted half black, half white.

By the use of each of these methods Mr. Trotter succeeded last summer in proving that in the arc there is a *phenomenon of rotation* of something, the precise nature of which is not yet known. The discovery was communicated in due course to the Royal Society.* The essence of the stroboscopic method is that it gives a stationary or slowly moving view of a rapidly moving object. If a thing is revolving so fast that the eye cannot follow it, it may be readily seen if the observer is furnished with an apparatus which will allow the eye only to catch a momentary glimpse once in each revolution. Suppose that just at the instant when one slit passes the eye the revolving thing is in a certain position, and that by the time the next slit has come opposite the eye, the revolving thing has gone exactly once round, the eye will see it as though it had not moved. If the frequency with which the slits pass the eye does not precisely correspond, the revolving object will seem to revolve slowly, either forward or else backward, according as the frequency is either too small

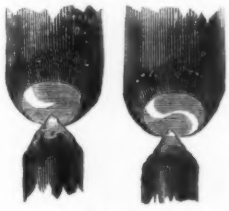


Fig. 20.

or too great. The thing that Mr. Trotter has found in the arc is a white object, having a sickle-shape or comma-shape, extending from some place near the middle of the crater to its edge, and revolving in a singularly capricious manner. The wandering whitish spot that is seen without the use of any revolving discs, is apparently the head of the comma-shaped object, the tail of which moves usually so fast, that its form cannot be seen, except by the use of the revolving slits.

By the kind co-operation of Mr. Trotter I am able to show you this rotatory phenomenon. An arc lamp arranged to be hand-fed is enclosed in a box. In front of the lamp is a small lens to throw an image on the screen, and immediately in front of the lens is a rotating disc of tinned iron, provided with slits, mounted upon the shaft of a small but rapidly revolving electric motor. The slit-disc as it revolves cuts off the light and restores it intermittently. We can vary the intermittences from 200 to 400 per second by changing the speed of the motor. What we have to do is to project a well-formed image of the crater upon the screen, and watch it while the rotating disc gets up speed, until the right speed is attained. We then see a sickle-shaped white patch (fig. 20), which appears to rotate slowly

* *Proc.* Roy. Soc., June 21st, 1894, lvi., 262.

backwards or forwards about a point as centre, or to stand still, according as the rotating slits go too quickly or too slowly, or keep in perfect synchronism with it. It usually has its centre in the middle of the crater surface, and extends to the edge. It is, at the present moment, in very rapid rotation; now it apparently decreases its speed, and stops for a moment, so that its shape is clearly visible. It appears as though the luminous part of the crater were shaped like the blade of a chaff-cutter, and whirled round with great rapidity. Now it changes its direction, and goes too quickly to be visible. Sometimes, when the speed of rotation of the object on the crater surface is only half as great as the speed of the disc, you get two views of the sickle-shaped object at opposite sides, forming a double figure (fig. 20); and sometimes one gets a treble appearance, or even four sickles, meeting like a star in the centre. Supposing you have the rotation well developed, and then alter the current gradually, the speed changes in a perfectly regular way; and yet, supposing there is a given current, and the thing is going round at one particular speed all of a sudden, without any warning whatever, the direction of the rotation may reverse, and yet keep the same rotatory speed. When it reverses its direction of rotation it reverses its form also; the concave edge being always the advancing one. That is one of the most puzzling things in the whole phenomenon. Apparently, with each current there is a particular speed of rotation that corresponds. The rotation is not a mere optical phenomenon of the surface of the crater, for, taking a lateral view of the arc, and examining the flame part between the crater and the peak, Mr. Trotter has found evidence that the flame is itself, from top to bottom, also in a state of rapid rotation corresponding to what one sees in this white sickle-shaped body going round on the crater surface.

Interesting and puzzling as the Trotter phenomenon is, I fear it puts an end to the hope that the crater of an arc lamp might be used as a standard of light.

Recent Observations by Mr. Crompton.

Mr. R. E. Crompton has lately noticed another arc phenomenon which was previously unknown, unless, indeed, it has been casually observed without the reason for it being known. It is the following. An arc may be burning perfectly steadily—of the proper length—everything going on without the smallest hint of any discontinuity, and all of a sudden, for apparently no reason whatever, the arc will enlarge itself flaming out sideways, and the flame will go up round the upper carbon, and lick round it once or twice, and then everything will resume its former condition. Mr. Crompton observed this under the following circumstances. In order to study the feed mechanism of different lamps, and to find out which was doing its duty best, and also to study the properties of carbons with a lamp of any particular mechanism, he took records with a recording voltmeter of the difference of potentials between the carbons of the arc, and obtained a very large number of curves. If a recording voltmeter is put across the terminals of a lamp, and the feeding mechanism sticks, you have a record of the fact by a slight kick in the curve. If the feeding mechanism stops, and the feed does not take place when it ought to do, the arc will lengthen unduly, and the voltage across will rise, and that rise will go on for some time until the feeding mechanism does choose to work. As a general rule, a feeding mechanism which waits too long feeds too much. It overfeeds because it has waited too long, and down comes the voltage suddenly, causing a deal of irregularity before the steady condition of things is resumed. All this will be duly recorded in the irregularities of form of the curve drawn by the instrument. With a more perfect arrangement of feeding mechanism, you will have comparatively small changes in the voltage. Records of this sort enable an engineer to pick out that particular mechanism, or to find the particular adjustment of mechanism which will give the most equable voltage on the lamp, and, therefore, obviously will cause the lamps to burn with the least flickering. Thanks to Mr. Crompton's kindness, I have here a number of these records. In this case the records are taken, not from a variety of lamps with different feeds (good and bad), but from a single lamp with a good feed. The object of this particular set of records was to study the different qualities of carbon in the same lamp. The first record shows a very even line; there are very slight undulations upon it; the feed was doing its duty; the carbon had got burnt down to a short stem, and the rod had descended, as far as the stop would allow it to; the arc became too long; the flame burnt itself out; the potentials rose until the arc broke, and the record stops in the middle of an up-stroke. The next record shows the same quality of carbon in use, but with two strange differences from the previous one. There are a number of small details, which indicate that the feed was taking place at more or less regular intervals. It is a very fair curve, with a number of little nicks in it, which show that the feed had taken place rather more markedly than usual; but at two places in this record there is a great disturbance. In the middle of the comparatively quiescent line there is a sudden irregularity, which then settles down. Now, a great disturbance like that may be due to the following circumstances. The particular kind of carbon used was one which had certain impurities in it. All carbons have impurities, but this appears to have had impurities of a particular kind, whether silica, lime, iron, or what, I do not know. When the carbons were examined, the following peculiarity appeared. Behind the crater, right up at the wide part of the conical surface, there accumulated, as there usually does accumulate upon the carbons of arc lamps, a brownish dust. In the present case, as soon as a sufficient quantity of dust had accumulated upon the base of the cone, the arc suddenly spread upwards, and like a good housemaid, swept off the dust with a tongue of flame, and then subsided; waited until a further aggregation of dust had accumulated, and then went housemaiding again. Among these records, several of which show this same phenomenon, there are some curious things, one of which illustrates the suitability or otherwise of a particular kind of arc lamp for use in a particular kind of building. In one case, where there are a number of cases of slight overfeeding, the record suddenly becomes very quiet indeed, the curve from that moment onward becoming almost a uniformly straight line. The record is marked as follows:—"*A* to *B* tea time, nobody walking about overhead." The lamp was suspended by a cord over a pulley, and the vibration of the building had caused the feeding to be a little irregular at times; but when there was no vibration the feed was more regular. It is not with all lamps that this occurs. Some lamps burn better in a building where there is a little vibration to joggle the feed and prevent it waiting too long. Again, if a lamp is set to work at a certain voltage, and then you use it at a voltage that is wrong, you get irregularity. Here, for instance, is a lamp of which the record at 40 volts is a most beautiful straight line, there is hardly the slightest irregularity, but the same lamp worked at 52 volts across the terminals is highly irregular. There is a regularly recurrent irregularity in the action of the feed at this higher voltage. Again, another fact Mr. Crompton has observed by following out these records, viz., that if carbons are left in a damp place where moisture can be slowly and regularly imbibed into the pencils, such a carbon, even although of good quality, may give rise to great irregularities. Here is a very irregular record, for instance, obtained from an extremely good carbon, one of Hardtmuth's make. That same carbon taken out and dried in a stove above steam temperature for two days gives a record which has not a flaw in it. Apparently the warmth of the hot air ascending up from an arc is not sufficient to drive out from a carbon the moisture which has been slowly accumulating in it. It seems to be very necessary, if you would have an arc burn with great regularity, to keep your store of carbons in a dry place.

But this topic does not strictly belong to the optics of the arc; it relates rather to the question of the mechanism of lamps, which is the subject for my next lecture.

ELECTRIC LIGHTING REGULATIONS.

(*Continued from page* 644.)

19. "An aerial line shall not in any part thereof be at a less height from the ground than 18 feet, or where it crosses a street 30 feet, or within 5 feet measured horizontally, or 7 feet measured vertically from any building or erection other than a support for the line, except where brought into a building for the purpose of supply."

Some minor objections were urged against this, but they were not important.

20. "Service lines from aerial lines shall be led as directly as possible to insulators firmly attached to some portion of the consumer's premises which is not accessible to any person without the use of a ladder or other special appliance, and from this point of attachment they shall be enclosed and protected in accordance with the regulations hereinafter contained as to service lines on the consumer's premises. Every portion of any service line which is outside a building, but is within 7 feet from such building, shall be completely enclosed in stout India-rubber tubing."

Some modifications were suggested to this, and the Chairman said the objections would be considered.

21. "When an aerial line crosses a street, the angle between such line, and the direction of the street at the place of such crossing, shall not be less than 60°, and the spans shall be as short as possible."

There were no remarks on this.

22. "Where an aerial line crosses, or is in proximity to, any metallic substance, precautions shall be taken by the undertakers against the possibility of their line coming into contact with such metallic substance, or of such metallic substance coming into contact with their line by breakage or otherwise.

There were no suggestions except one from the National Telephone Company.

23. "Every high pressure aerial line shall be efficiently suspended by means of insulating ligaments to suspending wires, so that the weight of the line does not produce any sensible stress in the direction of its length. All suspending wires, if of iron or steel, shall be galvanised."

After some observations, during which it was shown that systems of overhead wires had worked well without being suspended, the Chairman said he would consider objections.

24. "In the case of any aerial line exceeding one half mile in total length, means shall be provided whereby the pressure may be discharged from any portion of such line erected over or alongside of any building or buildings without loss of time in case of fire or other emergency."

Institution of Electrical Engineers suggested—Line 1, after word "any" insert words "high pressure."

This was accepted.

25. "Every aerial line, including its supports and all the structural parts and electrical appliances and devices belonging to, or connected

with such line, shall be duly and efficiently supervised and maintained as regards both electrical and mechanical conditions."

No observations.

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26. "An aerial line shall not be permitted to remain erected after it has ceased to be used for the supply of energy, unless the undertakers intend, within a reasonable time, again to take it into use."

No observations were made on this.

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27. "All conduits, pipes or casings, used as receptacles for electric lines shall be constructed of durable material, and of ample strength to prevent damage from heavy traffic, and, where they are laid in streets in which gas mains are also laid, shall be so constructed as to prevent any influx of gas from the adjacent soil."

This clause called forth considerable discussion, the principal objection being that it would be difficult to keep out gas from the boxes.

The Institution of Electrical Engineers suggested—Substitute for regulations 27 and 35, "All conduits, pipes, street boxes or casings, used as receptacles for electric lines, shall be constructed of durable material, and wherever they are laid under carriage ways, shall be of ample strength to prevent damage from heavy traffic; and reasonable means shall be taken by the undertakers to prevent accumulation of gas. The undertakers shall regularly inspect their street boxes for the presence of gas, and should any influx or accumulation be discovered, the undertakers are to give immediate notice to the gas authority."

That undertakers should only be required to take precautions against accumulation of gas.

That risks from explosions caused by influx of gas are very small save under very exceptional circumstances, such as the frost of last winter. When so many gas mains are broken, as was then the case, it is impossible to prevent influx of gas to chambers underground.

Suggest stricter enforcement of Gas Acts.

In the discussion that followed, Mr. Albert Gay (Islington), said the clause would place a serious responsibility upon electric undertakings. No conduit system could be gas or air-tight, and if the clause were to be retrospective, it would mean the expenditure of enormous sums of money. The gas companies say they cannot keep gas in their pipes, therefore it was impossible for electric light companies to keep gas out of the conduits. The clause would place a powerful weapon in the hands of the gas companies.

Mr. Hammond and Mr. Manville supported this view, and after further remarks,

The Chairman said he was prepared to accept the amendment put forward by the Institution of Electrical Engineers, but the electric light undertakings would have to take precautions in preventing accumulations.

Prof. Ayrton, on behalf of the Institution of Electrical Engineers, expressed his thanks for the chairman's concession.

The Conference then adjourned till the following day.

Wednesday's Proceedings.

In opening the proceedings on Wednesday morning, Sir Courtenay Boyle said he had considered the important representations made yesterday on the subject of a definition of low pressure. The importance of that definition was made clear to him by the arguments used yesterday. The points raised were highly technical and highly scientific, and he had come to the conclusion that it would not be possible for him to give a definite and final definition to the Board of Trade, but he thought it would be to the convenience of those interested in the discussion that the decision should be reserved for some time, and that the Board should appoint a small committee not exceeding three expert officers to carefully consider the scientific aspect of the question, and recommend to the Board of Trade.

Major-General Webber said that so far as the Electrical Engineers were concerned, they heartily concurred in the wisdom of the proposal.

Similar expressions of approval having been forthcoming from other representatives, this course was agreed upon.

Regulation 28 was then considered:—"Where any electric line crosses, or is in proximity to any metallic substance, special precautions shall be taken by the undertakers against the possibility of any electrical discharge to the metallic substance from their line or from any metal conduit, pipe, or casing enclosing their line."

The representative of the Bournemouth Company thought the clause superfluous. Clause 29 settled the question, and if that stood, 28 and 30 might be dispensed with.

Major Cardew said that if Clause 29 was effectively carried out, to a large extent it prevented any such danger as anticipated by Clause 28, but at the same time that was a very important matter, and several cases had occurred of damage to pipes, and they should have every reasonable safeguard, and he thought both clauses should stand. He thought that electric lines should be enclosed, and where other people's pipes were near, there should be some kind of insulating.

The Chairman said he was against the contention of the representative of Bournemouth.

A gentleman asked if they would substitute "insulating material." Would a brick case do?"

Major Cardew: A hard brick would.

Mr. Crompton said that on Clause 29 the Electrical Institute raised the point that the regulation should only apply to high pressure.

Major Cardew said that was dealt with in the next regulation.

The clause was then passed as follows:—"All metal conduits, pipes or casings, containing any electric line shall be efficiently connected with earth; and shall be so jointed and connected across all street boxes and other openings as to make good electrical connection throughout their whole length."

Clause 30 was next taken under consideration:—"Where isolated lengths of metal conduit, pipe or casing, are used for the protection of any electric line at road crossings or similar positions, there shall be interposed between such electric line and the conduit, pipe or casing, such additional insulating material as will prevent the possibility of any electrical charging thereof."

The representative of the Manchester Corporation asked if four gradings was sufficient in the cable.

Major Cardew: It sounds so; I would like to see it.

The Manchester representative: I will send you a sample.

Regulation 31 read:—"Where the conductors of electric lines placed in any conduit are not continuously covered with insulating material, they shall be securely fixed in position, and no unfixed material of a conducting nature shall be contained in the conduit.

"Adequate precautions shall also be taken to ensure that no accumulation of water shall take place in any part of the conduit, and to prevent any access of moisture to the conductors or the insulators; and the latter shall be so disposed that they can be readily inspected."

Mr. Crompton said the words, "secured fixed in position," were indefinite.

The Chairman: We will take your word, "secured."

Mr. Crompton said the words, "and to prevent any access of moisture, &c.," to the end of the clause, were impossible under many existing circumstances.

Major Cardew said it was thought to be desirable, after what had happened on the St. Pancras system, whereby it appeared that they had no means of obtaining any information in a ready manner as to what conditions their insulators were in, although dangerous deposits might be shown. It seemed reasonable that those insulators should be examined in some way.

Prof. Kennedy said he understood what was wanted by the Board of Trade was that the length could be pulled up and looked to, or that a man lying on the pavement could, by the aid of a light, see if anything had gone wrong.

Major Cardew replied that that was the meaning he certainly had, so that they would be able to see in some way if there was any dangerous deposit.

Mr. Banes said that with regard to the St. Pancras mains, it would be impossible to carry out the suggestion of Prof. Kennedy. It would mean rearranging the mains throughout the district. They had something like £40,000 of mains sunk, and it would be a most serious thing for them. They had taken every precaution to carry out an efficient system of ventilation, and lately he had had the mains open in sections throughout the district, and he was surprised to find the insulators particularly clean.

The Chairman said the clause would be prospective, but it was desirable that undertakers should act up to it as much as possible.

Clause 32 read:—"Any portions of any high pressure electric lines placed above the service of the ground, or in any subway, shall be completely enclosed either in a highly-glazed porcelain tube embedded in brickwork, masonry, or cement concrete; or in strong metal casing efficiently connected with earth, and so protected and guarded as to prevent accidental contact with the casing."

The Chairman said he would accept the suggestion of the Electrical Institute to insert after the word subway, "not in the sole occupation of the undertakers." What they meant was a County Council subway.

Mr. Nesbitt asked if the words, "and so protected and guarded as to prevent accidental contact with the casing," referred to the conductor or the insulator with the casing.

Major Cardew said it meant any contact with any high pressure electrical line with the casing. He thought the definition wanted a little alteration.

The Chairman said they might take out the semi-colon and insert the words "it shall be" in place.

Major Cardew, replying to further questions by Mr. Nesbitt, said the meaning of the clause was, that there should be some external protection to casing to prevent people passing being brought into accidental contact with it. Take, for instance, high pressure leads brought up inside a post. The idea was, that the lead should be inclosed in a metallic casing, and that the metallic casing should not be so exposed so that it could be touched. They did not require that the lead should be insulated. He had known a case of an iron post buried 10 feet in the earth becoming highly charged by contact with an electric line not exceeding 300 volts.

Mr. Morse moved that the words "or similar material" should be added after the words "glazed porcelain tube." His object was, that the material might not be confined to one trade.

Major Cardew said that he would suggest it should read, "a tube of highly insulating material," and this was agreed to.

It was agreed that Clauses 33 and 34 should be considered together. They were:—33. "Every high pressure electric line transmitting more than 50,000 watts, or used for the supply of energy to transformers placed in street boxes, shall, except within the generating station, be entirely enclosed in strong metal casing efficiently connected with earth, and such casing shall not contain any low pressure electric line." 34. "High pressure electric lines not intended to

transmit more than 50,000 watts may be enclosed either as provided in the preceding regulation, or in glazed stoneware casings properly laid and jointed in cement at a depth of not less than 2 feet below the surface of the ground and sufficiently protected against breakage."

Mr. Crompton said that at a largely attended meeting of engineers they adopted a resolution to take the place of the two resolutions, as follows:—"Every high pressure electric line transmitting more than 50,000 watts shall, except within the generating station or sub-station, be entirely enclosed in strong metal casing efficiently connected with earth, or in stoneware or other suitable casing, and such casing shall not contain any low pressure electric line, unless this line is a concentric cable with the outer conductor earthed." That was simpler, and seemed to carry out all their wishes, and it was workable.

Mr. Hammond said that for some time past he had been obliged to use iron culverts in high tension works where he would like to use stone. Taking the two clauses together, he would draw attention to the stipulation made in 34, that where stoneware culverts were used they should be placed at a depth of not less than 2 feet. If that clause were inserted, it would take away entirely the advantage of the permission to use stoneware culverts. Stoneware culverts were only practicable where the conductors were placed below the pavement, and in those cases there was rarely a depth possible of 2 feet; in fact, he might say it was never possible.

Mr. Sayers supported the Institute clause.

After further conversation the Chairman said it would be better to go back to the old regulation, instead of the new clauses, as follows: "Where any high pressure conductor is laid within a less distance than 18 inches from any low pressure conductor, or from the surface of the ground, or where any low pressure conductor is laid within the above-mentioned distance from any previously laid high pressure conductor, efficient means shall be taken to render it impossible that the low pressure conductor on the surface of the ground shall become electrically charged by any leakage from or defect in the high pressure conductor."

Discussion next took place on Clause 35—"All street boxes which contain any vacant space shall be so constructed as to prevent any influx of gas or water, either from the adjacent soil or by means of any pipes, and ample provision shall be made, by ventilation or otherwise, for the immediate escape of any gas which may by accident have obtained access to the box, and for the prevention of danger from sparking."

The Chairman said that that clause was not intended to apply to ordinary street boxes, but to transformer chambers. It might read: "In the construction of street boxes containing any vacant spacing."

Major-General Webber: That will apply to every street box.

The Chairman said he supposed there was a space in every street box. Was it desirable to ventilate all street boxes? (No, no.)

Major-General Webber said that before they made any absolute rule respecting ventilation, the matter should be considered again by the board.

Mr. Hammond pointed out that they had three kinds of boxes—junction boxes, house boxes, and transformers. If they had a proper definition of street box, it would greatly facilitate the matter. If the rule was only for the transformer chambers, he did not think it was too stringent.

The Chairman said the rule would be limited to transformer chambers, and the difficulty came in how to define them.

Replying to a suggestion of Mr. Hammond to leave out all words after "adjacent soil," the Chairman said he was quite convinced if gas got in, and did not get out, there was considerable danger of explosion. Could it read: "In the construction of street boxes containing any transformer, or exceeding 1 cubic foot in extent, efficient means shall be taken to prevent any influx, &c.?"

Mr. Crompton called attention to the need for further definition of different boxes.

Eventually it was agreed that the clause should read: "In the construction of street boxes, used as transformer chambers, reasonable means shall be adopted to prevent, as far as possible, any influx of gas, &c."

Clause 36 was amended so as to read: "The covers of street boxes shall be so constructed that they can only be opened by proper appliances, and shall, where the box contains high pressure apparatus other than cables, be connected to strips of metal laid immediately underneath the adjacent roadway or pavement."

After a little discussion, it was decided to strike out clause 37: "The casing of any high pressure electric lines shall be continued within street boxes."

Regulation 38 was as follows: "All converting stations, or points in a system of distribution to which a high pressure supply is given from generating stations, and from which a low pressure supply is given to consumers, shall be established in suitable places, which are in the sole occupation and charge of the undertakers."

The Chairman said he thought the regulation should read, "transformer" chambers, and not "converting."

It was agreed that the word "transformer" should be substituted for the word "converting" in the regulation.

Mr. Crompton took exception to the words, "shall be established in suitable places," as being superfluous.

Mr. Gunyon said that, speaking on behalf of the County Council, he thought the words were of value, and therefore should be retained. They could not possibly do any harm.

Mr. Crompton said it really meant that the County Council would have another opportunity of looking into the affairs of the electric light companies. The Council had to pass the mains as a whole, and he certainly did not see why they should have these particular words put in.

Prof. Ayrton said that the words "sole occupation," in the regulation, required some attention to be given to it. He had certain transformer chambers in his mind which were in buildings that had been built by a private consumer, and the question was, was it imperative on that private consumer to hand over the ownership of that transformer chamber to the supply company. At the present moment those chambers were regarded as the property of those who used the light, although, of course, the undertakers were at liberty to go there when they chose. The regulation seemed to imply that the person using the light should have to transfer their property to the undertaker, and they might legally object to it.

The Chairman pointed out that it was only the occupation which was to be transferred—not the ownership.

Mr. Hammond said he would like to see the words, "sole occupation," omitted from the regulation, and he suggested that "sole charge" might be substituted.

After some further discussion, it was agreed, on the suggestion of the chairman, to go back to the old 16 clause, which he said seemed to work very well.

Regulations 39 and 40 were agreed to as follows, without discussion:—

39. "The undertakers shall be responsible for all electric lines, fittings, and apparatus belonging to them, or under their control, which may be upon the consumer's premises, being maintained in a safe condition, and in all respects fit for supplying energy.

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40. "In delivering the energy to the consumer's terminals the undertakers shall exercise all due precautions, so as to avoid risk of causing fire on the premises."

Regulation 41 was as follows:—

41. "A suitable safety fuse, or other automatic disconnector, shall be inserted in each service line as close as possible to the point of entry to any consumer's premises, and contained within a suitable locked receptacle of fireproof construction."

After some discussion, the Chairman said he would accept the words "locked or sealed" receptacle, and also the addition of the words, "except in cases where the surface line is protected by fuses in the street boxes."

Several delegates raised the point as to whether the regulation meant that the safety fuse was to be inserted outside or inside the premises.

The Chairman said there could not be the slightest doubt but that it meant outside.

Prof. Kennedy expressed the hope that the regulation would not be made retrospective.

Mr. Heaphy said he would like to see the regulation altered. People often complained that the surface lines were placed in buildings in such a position that they were calculated to get damp very soon, and he found that the cut-outs were placed sometimes 3 feet from the point of entry, and he could not find the switch until 12 or 13 feet off. That he thought a most serious state of affairs, and some day he predicted there would be a very serious fire in consequence. He would suggest that the undertakers should put up switches as well as cut-outs at the point of entry of the surface lines into the premises.

A delegate pointed out that such a provision would be extremely inconvenient, and would put the companies to a great deal of unnecessary trouble.

The Chairman said he thought they had better discuss the regulation as if "to" meant "in."

Mr. Hammond said he hoped, with Prof. Kennedy, that the regulation would not be made retrospective. It would certainly be very hard upon local authorities, as it would involve them in a great deal of expense. He thought the word "hereafter" should be added to the clause.

The Chairman said they might rely upon the Board of Trade giving reasonable time, but he certainly thought that the fireproof construction was an urgent necessity.

The regulation was then agreed to.

Regulation 42 was as follows:—42. "All low pressure electric lines and apparatus placed on any consumer's premises shall be highly insulated and thoroughly protected against injury to the insulation or access of moisture, and no metal forming part of the electric circuit shall be exposed so that it can be touched. All electric lines shall be so fixed and protected as to prevent the possibility of electrical discharge to any adjacent metallic substance."

Mr. Heaphy thought the regulation was a very good one indeed.

Mr. Hammond said he had intended to object to the regulation, but as he saw that it did not apply to Ireland, his objection was removed. He, however, would like to put in the words, "belonging to the undertakers."

General Webber said he should object to such an addition.

Eventually the regulation was agreed to.

Regulation 43 was as follows:—"Where transformers are installed within buildings on consumers' premises, they shall be contained in a fireproof chamber, securely locked, and the high pressure service lines in highly glazed porcelain tubes bedded in chases cut in brickwork or masonry."

Mr. Schoolbred (Birkenhead) enquired at whose expense the alterations would have to be made?

The Chairman: That is a matter which depends upon the particular provisions of the particular orders under which the undertakers are working.

The representative from Halifax suggested that the old clause 18 be substituted for the present proposal, and this suggestion was supported by Mr. Crompton and others.

The Chairman said he thought that the general concensus of opinion was in favour of going back to clause 18.

This was agreed to.

After some discussion, it was agreed to deal with the following regulations together:—

44. "If the undertakers are reasonably satisfied, after making all proper examination by testing or otherwise, that a connection with the earth exists at some part of a circuit of such resistance as to be a source of danger, and that such connection does not exist at any part of the circuit belonging to the undertakers, then and in such case any officer of the undertakers, duly authorised by them in writing, or, if the undertakers so require, an electric inspector may, for the purpose of discovering whether such connection with the earth exists at any part of a circuit within or upon any consumer's premises, at all reasonable times, after giving one hour's notice of his intention to do so, enter any such premises and disconnect the consumer's wires from the service lines, and may require the consumer to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit.

"In any case where the undertakers require the services of an electric inspector under this regulation, they shall pay him the prescribed fee."

45. "If on such testing the officer or the electric inspector discovers that a connection exists between the consumer's wires and the earth, and that such connection has an electrical resistance not exceeding 5,000 ohms, or if the consumer does not give all due facilities for such inspection and testing, the undertakers shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of such discontinuance to the consumer, and shall not recommence such supply until they are reasonably satisfied that such connection with the earth has been removed.

"Provided that in cases where the maximum power taken by any consumer exceeds 25,000 watts, the consumer's wires may be divided for the purposes of this testing into separate circuits, the insulation resistance of each of which shall exceed 5,000 ohms."

46. "If any consumer is dissatisfied with the action of the undertakers either in discontinuing or in not recommencing the supply of energy to his premises, the wires and fittings of such consumer may, on his application and on payment of the prescribed fee, be tested for the existence of connection with the earth by an electric inspector.

"This regulation shall be endorsed on every notice given under the provisions of the last preceding regulation."

Mr. Hammond said that the regulations in question were very important. He would almost go so far as to suggest that the Board of Trade should lay down rules for wiring, as well as rules for distribution.

The Chairman said that the Board of Trade had always kept themselves out of private premises; they went upon the principle that an Englishman's house was his castle.

Mr. Hammond said they would like to have a regulation enabling them to refuse to give a supply to customers who were causing the installation to break down. The rule which generally obtained, and which he would suggest, was that no installation should be connected which, when completed, would have a lower insulating resistance in ohms than 75, divided into the number of lamps fixed. He certainly thought they should have power of cutting off a consumer whose installation did not come up to that standard.

Prof. Ayrton remarked that Clause 45 was a compulsory one, and nobody could object to such powers being given to the undertaker; but what the undertakers wanted, in the interests of the electric lighting industry as a whole, was something beyond that. Mr. Preece had drawn attention to the bad work which was often put in houses, and to avoid that, the supply company issued certain regulations, without compliance with which they would not supply the current; but there was always the difficulty that the insulation resistance was not up to their standard. In the interests of the whole electrical industry, it was necessary, in his opinion, that the companies should be armed, and the householder also, with some clause by which the contractor should know that, unless the work was of a proper standard, there was no prospect of the supply company turning on the current. That would be of the greatest possible effect in getting the consumer to insist upon having good work put in.

The Chairman said that the only *raison d'être* of regulation 45 was that in extreme cases it gave undertakers the power to cut off.

Prof. Ayrton said it was perfectly true that under the Act the undertakers had power to cut off, but the feeling among the public generally was that they could only cut off provided the insulation was less than an extremely low standard.

The Chairman suggested that at the end of clause 45 the following words might be added: "This regulation shall not affect any power contained in any order, or otherwise, enabling the undertakers to discontinue the supply."

Major Cardew suggested that in place of a limit of 5,000 ohms, the words should be inserted, "sufficient to cause a leakage of current exceeding one-thousandth part of the current supplied to the premises."

Prof. Kennedy said he thought it would meet the wishes of all present if the regulation should provide that no undertaker should connect up a consumer whose insulation was less than 65 or 70—or any number which they might fix upon as a minimum—and that they should disconnect anyone whose insulation fell below the agreed standard.

The Chairman said he thought the suggestion of Prof. Kennedy's a very good one, and ultimately he agreed to deal with the clause in this way: "That the undertakers are not to be obliged to connect up unless the insulation resistance is above a certain X, to be fixed, and they must cut off if it falls below another X, to be fixed."

Regulation 47 was agreed to as follows, without discussion:—"All arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and shall not be used in situations where there is any danger of the presence of explosive dust or gas."

Regulation 48 was as follows:—"Arc lamps used in any street shall be so fixed as not to be in any part at a less height than 10 feet from the ground."

The representative from Liverppol said that he would like to see the clause amended so as to read 8 feet instead of 10. If they had to put arc lamps 10 feet high, the light would be useless for shops.

The Chairman said he would amend the clause so as to make it clear that it referred to street lamps only, and for arc lamps used for private lighting he would reduce the height to 8 feet on the condition that they were to be screened.

Regulation 49 was as follows:—"A cut-off switch, fixed in a suitable locked receptable, shall be provided for every high pressure arc lamp, and such switch shall be of such pattern and construction as will provide:—(*a*) That the lamp can by its means be entirely disconnected from the supply circuit; (*b*) that the switch itself can be safely operated in the dark by an inexperienced person and without special precautions; and (*c*) that there shall be no danger of any injurious electrical arcing, sparking, or heating being caused by the operation of the switch."

The representative of the Blackpool Corporation expressed the opinion that section (*b*) was of too stringent a character. He had about 150 different arc lamps under his control, but he should never think of sending out an inexperienced man to operate the switches.

Mr. Gunyon thought the words should remain in.

The Chairman eventually decided to eliminate the word "inexperienced" from section (*b*), and the regulation as amended was passed.

Regulation 50, dealing with penalties, read as follows:—"If the undertakers make default in complying with any of the preceding regulations, they shall be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10. The imposition of any penalty under this regulation shall not affect the liability of the undertakers to make compensation in respect of any damage or injury which may be caused by reason of such default."

The Town Clerk of Hull said that his corporation felt that if the penalty clause stood as it was, it might have the result of throwing upon electric lighting undertakers the responsibility for damage, which primarily belonged to other companies. The electric lighting undertakers were very anxious to carry out all the regulations, but they had to depend upon human agency, and they were, therefore, liable to errors. Under the proposed clause, however, he was afraid that persons might use it to shift upon the shoulders of the electric company responsibility for an accident for which they were only secondary responsibility. That condition of things might arise in the case of an accident caused by an escape of gas.

The Chairman said that he was advised by counsel that the word "affect" meant affect either way, and he did not think it wise to begin fiddling with that meaning. Perhaps the views of Hull would be met if they inserted the words, "nothing in these regulations shall alter the liability."

The Town Clerk of Hull said that that was exactly what he wanted.

The Chairman said he would consider the point. There was some little difficulty from counsel's point of view about the matter, but he would deal with the point in the best way he could.

The regulation was then agreed to.

The Conference then proceeded to consider the regulations as to supply, the first of which was:—"One week at least before the undertakers are ready to commence to supply energy through any feeding, charging, or distributing main, they shall serve a notice upon the local authority of their intention to commence such supply."

Mr. Hammond thought that one week was too long a time; 48 hours should be ample.

Mr. Crompton remarked that he thought they would all agree with Mr. Hammond that it seemed utterly unnecessary to ask for a week.

Mr. Gunyon said he had no objection to shortening the notice, and the regulation was agreed to, with the substitution of 48 hours for a week.

Regulation 2 was as follows:—"From and after the time when the undertakers commence to supply energy through any distributing main, they shall maintain a supply of sufficient power for the use of all the consumers for the time being entitled to be supplied from such main; and such supply shall, except so far as may be otherwise agreed upon from time to time between the local authority and the undertakers, be constantly maintained. Provided that, for the purposes of testing, the authority by whom the electric inspector is appointed may give permission to the undertakers to discontinue the supply at such intervals of time, and for such periods as it may think expedient, and that for any other purposes connected with the efficient working of the undertaking, the undertakers may, with the permission of the Board of Trade, discontinue the supply at such intervals of time, and for such periods as the Board of Trade may

think expedient. Where the supply is so discontinued, notice of such discontinuance, and of the probable duration thereof, shall be forthwith served upon the local authority."

After some discussion the regulation was agreed to, with the addition of the words after the word "testing," "or for any other purposes connected with the efficient working of the undertaking."

The three following regulations were agreed to without comment:

3. "The system of distributing mains shall be so arranged that in case it becomes necessary to stop the supply through any portion of a main for more than one hour, for the purposes of repairs, or for any other reason, the stoppage of supply will in no case exceed in amount a maximum power of 200,000 watts, or extend to the premises of more than 80 consumers, and in the case of every stoppage for more than one hour, reasonable notice shall be previously given by the undertakers to every consumer affected thereby except in cases of emergency."

4. "During the whole of the period when a supply of energy is required to be maintained by the undertakers in the distributing mains under the order and these regulations, it shall be maintained at a constant pressure (in these regulations termed the 'standard pressure') to be fixed as hereinafter specified; but such standard pressure may be different for different portions of the distributing mains. Provided that the undertakers shall be deemed to have complied with the requirements of this regulation so long as the pressure does not at any point vary more than 3 per cent. from the corresponding standard pressure in the case of a general supply at low pressure, or 2 per cent. in the case of a general supply at high pressure, unless changes in pressure recur so frequently as to cause unsteadiness in the supply."

5. "The standard pressure shall be fixed by the undertakers for every pair of distributing mains, and notice of the amount of such standard pressure shall be given to the local authority before the undertakers commence to supply energy to consumers through such mains, and such standard pressure shall not be altered except by permission of the local authority, and upon such terms and conditions as the local authority may impose, and after public notice has been given during a period of one month, in such manner as the local authority may require, of the intention of the undertakers to apply for permission to alter the same. The undertakers may appeal against any decision of the local authority under this regulation to the Board of Trade, whose decision shall be final."

Regulation 6 read as follows:—"Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not, except by agreement, be greater than 150 volts or less than 45 volts, if continuous, or the equivalents thereof respectively, if alternating, and shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In distribution on the three-wire system, the central terminal shall for the purposes of this regulation be considered to form a pair with either of the outer terminals, and, similarly, for multiple wire systems; and, in the case of a transformation of energy on the consumer's premises, the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be the declared constant pressure."

Mr. Crompton said he thought it would be better if this regulation was not dealt with at present.

The Chairman said that was so, for it depended upon the decision arrived at about the definition of pressure, and the clause would, therefore, be reserved.

Regulation 7 was as follows:—"The variation of pressure at any consumer's terminals shall not, under any conditions of the supply which the consumer is entitled to receive, nor at any time, exceed 4 per cent. from the declared constant pressure, whether such variation be due to the resistance of the service lines or apparatus belonging to the undertakers, or to any action or effect produced by such apparatus, for which the consumer cannot be shown to be responsible, or, partly to any variation of pressure in the distributing mains from which the supply is taken."

Mr. Crompton said he would like the words "nor at any time" omitted, and after the word "exceed," he would like inserted the word "continuously." The object of those alterations were very obvious, for it could not be meant that a slight blink in the light should be a contravention of the regulations—it was intended to mean a sufficiently permanent drop in the light to cause inconvenience to the consumer. He also wished to omit all the words after "pressure," where it occurred the second time in the regulation.

The Chairman said he did not like the word continuously.

Mr. Crompton replied that what they meant was that two or three seconds should not count.

The Chairman said he quite appreciated Mr. Crompton's point, and he thought it would be met if they omitted the words "nor at any time." He, however, could not accept the word "continuously."

After some further discussion the regulation was agreed to, with the two omissions desired by Mr. Crompton, but without the addition of continuously.

The last clause (8) as follows, was agreed to without comment:—"If the undertakers make default in complying with any of these regulations as to supply, they shall, subject to the provisions of the Order, be liable to a penalty not exceeding £5 for every such default, and to a daily penalty not exceeding £5.

The Chairman said he had to thank the delegates for the kindness with which they had raised their objections to the regulations, and for the courtesy with which they had pressed them.

Mr. Alderman Gibson (Manchester) proposed a vote of thanks to Sir Courtenay Boyle for the kindness and courtesy he had extended towards the delegates.

This was seconded by Mr. Alderman Myles (Bolton), and carried.

The proceedings then terminated.

NEW PATENTS.—1895.

[*Compiled expressly for this journal by* W. P. Thompson & Co. *Electrical Patent Agents*, 31, *High Holborn, London, W.C., to whom all inquiries should be addressed. Copies of any of the specifications may be obtained of* Messrs. W. P. Thompson & Co., *price, post free*, 8½*d. (in stamps.)*]

20,164A. "Improvements in or connected with cathodes for use in the electrolytic deposit of metals." S. O. Cowper-Coles, M. Ulcoq, W. M. Guthrie, and C. R. G. Smythe. Dated November 14th.

21,357. "Improvements in or connected with telegraphy and telephony, and in electric relays for use therewith." E. J. P. Mercadier and H. R. J. Pierquin. Dated November 11th.

21,367. "Improvements in electrical indicating and recording meters." R. J. C. Wood and A. E. Mayes. Dated November 11th.

21,370. "Improvements in and relating to rotating brushes, applicable to moving electrical generators, motors, or machinery." S. Allingham and W. A. Clatworthy. Dated November 11th.

21,374. "Improvements in microphones." E. von Szvetics. Dated November 11th.

21,381. "Improved manufacture of carbon rods for arc lights." J. Roubal. Dated November 11th.

21,384. "Sensorial magnetic gun for shooting at movable objects and called the 'rabbit-shooting' game." J. Carpenter. Dated November 12th.

21,433. "Improvements in the holders or carriers of electrical incandescent or glow lamps." R. G. Evered. Dated November 12th.

21,460. "Improvements in electrical controllers and reversing switches for electric motors." W. H. Morgan. Dated November 12th.

21,484. "An improved method of and apparatus for governing or regulating motors." L. A. Enger. Dated November 12th.

21,498. "Improvements in carbons for electric arc lamps." W. H. Clegg. Dated November 13th.

21,543. "Improvements in apparatus for transforming continuous electric currents into alternating currents." C. D. Abel. (La Société Anonyme pour la Transmission de la Force par L'electricite, France.) Dated November 13th.

21,556. "Improvements in microphones or telephone transmitters." W. P. Thompson. (The firm of Hammacher and Paetzold, Germany.) Dated November 13th.

21,560. "Improvements in and relating to electric railways or tramways." J. C. Love and J. E. Hodges. Dated November 13th.

21,569. "Improvements in lock and block signalling on railways." W. R. Sykes. Dated November 13th.

21,586. "Improvements in electrical railway systems." J. McLeod Murphy, W. J. Dixon, and A. F. Pierce. Dated November 13th.

21,601. "Electrical apparatus for destroying rats and like animals." L. White. Dated November 14th.

21,623. "Improvements in the fittings of electric lamps." W. J. Fox. Dated November 14th.

21,638. "Improvements in electrical switches." J. W. Fielding. Dated November 14th.

21,644. "Improvements in means for obtaining gold from its solutions." S. O. Cowper-Coles, M. Ulcoq, W. M. Guthrie, and C. R. G. Smythe. Dated November 14th.

21,657. "Improvements in or relating to submarine telegraph cables." F. C. Crawford. Dated November 14th.

21,664. "Improvements in or relating to the running of alternate current dynamo machines in parallel. E. H. Fowler, and C. J. Hall. Dated November 14th.

21,679. "Improved means for use with electric cables for diverting the current through adjacent cables when required for repairs or other purpose." H. Edmunds. Dated November 14th.

21,752. "Improved system of using electric lights and other means of illumination." G. Cuthbert. Dated November 15th.

21,759. "Improvements in electric storage batteries or accumulators." T. W. Allan, A. Powell, and C. J. Tibbits. Dated November 15th.

21,763. "Improvements in electric tramway or railway systems." J. Fairclough. Dated November 16th.

21,798. "Improvements in and connected with telegraph and other signals." J. Nicholson. Dated November 16th.

21,817. "A new or improved apparatus for conveniently carrying portable electrical batteries, books, or other articles." T. W. Allan, A. Powell, and C. J. Tibbits. Dated November 16th.

21,818. "Improvements in fittings for incandescent electric lamps." T. W. Allan, A. Powell, and C. J. Tibbits. Dated November 16th.

21,830. "Improvements in electrical apparatus for firing fuses for mines or other purposes." Siemens Brothers & Co. (Siemens and Halske, Germany.) Dated November 16th.